FRAGRANT THUJA

Commonly called cedars, although they look much more like their close relatives, the cypresses, thujas have the most delightfully fragrant foliage of any tree.

Above: A majestic stand of western red cedars. These trees grow best in moist fertile soils but they can tolerate conditions in the drier eastern half of Britain and are also capable of withstanding a degree of exposure.
Sometimes referred to in old books, though never in practice, as the 'arbor vitae', the western red cedar can be distinguished at a distance from the Lawson cypress by the fact that you can always see through the former's crown.

The cypress family (Cupressaceae) is a large family of conifers containing some 18 genera, one of which is *Thuja*. This genus consists of just five species, one having been recorded only once, in central China, and is now probably extinct.

The main difference between *Thuja* and other genera in the cypress family is in the cones. That of a *Thuja* is oval and the cone scales are attached at the base of the cone. The usual cypress cone is roughly spherical and the scale is shield-shaped with a stalk at the centre attaching it to the cone.

In Britain, the most familiar *Thuja* is the western red cedar (*Thuja plicata*), which is commonly planted in parks and gardens as an ornamental tree, and also has a minor role in forestry schemes. Despite its common name 'cedar', the western red cedar bears no relation to the true cedars, such as the cedar of Lebanon, which belong to the genus *Cedrus*. The name 'cedar' has been given to many conifers with a fine durable timber.

American native The western red cedar is native to the temperate rain forests along the Pacific Coast of North America and on moist sites inland across the Rocky Mountains. It was introduced to Britain by Thomas Lobb, who was in western North America collecting for the nursery firm of Veitch.

In its native stands the western red cedar can grow taller than 60m (200ft) and in Britain some specimens have already exceeded 40m (130ft).

The western red cedar is often confused with the Lawson cypress because of the similarity of the foliage. However, the two species are easy to distinguish. Apart from the differences in the cones, the crowns are quite different. When viewed against the sky, you can always see through the crown of a western red cedar, whereas the crown of a Lawson cypress is either completely dense or consists of dense branches with clear spaces between. The crown of an old western red cedar lacks the irregular arching branches that give an old Lawson cypress such character.

The two species also differ in their leading shoots (the shoot at the very top of the tree). On the western red cedar it is always stiff and erect, never pendulous as it is on the Lawson cypress.

Leaves and cones The foliage is carried on short sprays borne alternately on each side of the twigs. In most specimens these sprays are flat, but in older trees they may become cupped with the tips arching upwards. The foliage remains green and alive for about two years, after which the leaves on the side shoots of the spray–called the laterals–die and are shed. Those on the main shoots of the spray–the primary shoots–may die and turn brown within a further year, after which they are slowly shed.

The foliage consists of sharp-tipped scaly leaves lying flat on the stem and completely clothing it. They are arranged in the same way as the leaves of a cypress: the leaves are borne in opposite pairs, each pair being set at right-angles to the pair next to it.

The leaves are yellowish-green, or sometimes dark shiny green if the tree is growing in shade. On the underside they are a pale shiny green with a broad whitish waxy band covering the stomata.

The young cones appear in spring on the ends of the shoots. After fertilisation, the female cones mature into elliptical structures about 1cm ($\frac{1}{2}$in) long. The cones consist of five or six pairs of cone scales, with just the middle three or four pairs carrying seeds, which are pale brown and about 3mm long.

Durable timber The western red cedar pro-

duces a very light, easily worked timber. In colour, it is reddish-brown (hence the epithet 'red' in the name of the tree) and it is very durable. It is most commonly used in Britain for building 'cedar' sheds and shingle roof tiles. The trunk of a western red cedar, being straight, uniform and rarely forked, is ideal for the tall round posts used in rugby.

White cedar The only other species of *Thuja* common in Britain is the white cedar (*Thuja occidentalis*). This tree is found in eastern North America, where it has a widespread though scattered distribution around the Canadian/USA border. It was introduced to France in 1536 and to Britain at about the same time. This makes it probably the earliest North American tree to be introduced to this country.

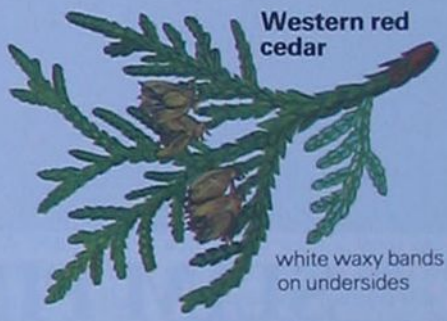
The white cedar is a much smaller tree than the western red, rarely reaching 20m (65ft), and has a thin regular crown. The foliage is a distinctive yellow-green and looks somewhat unhealthy. In the middle of each leaf, just below the tip, is a prominent pale gland, raised above the surface of the leaf. These glands are also found on the western red cedar but are not nearly so obvious on that species. The underside of the foliage is a pale yellow-green. It lacks the white waxy coating of the western red cedar.

The male and female cones are borne on the tips of the shoots. In March the male cones open to release pollen. The females mature to become similar in colour and shape to the cones of the western red cedar, though the former are usually slightly smaller. They differ in having only four fertile cone scales to each cone. However, they compensate by being borne profusely on the tree.

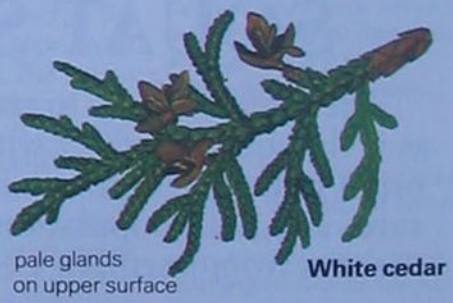
Unlike the western red cedar, the white cedar has no forestry use in Britain, though it has given rise to a large number of dwarf and slow-growing varieties which are often seen in gardens.

Above: A bushy variety of the white cedar, var. *filiformis*. Most *Thuja* species have distinctively fragrant foliage. The white cedar is said to smell of apples.

Opposite page: 'Zebrina', a cultivar of the western red cedar with yellowish foliage. The foliage of all western red cedars has a smell reminiscent of pineapple, particularly when bruised or crushed.



Right: The foliage and cones of our two most common species of *Thuja*.
Western red cedar (*Thuja plicata*). Evergreen tree native to western North America. Height to 40m (130ft).
White cedar (*Thuja occidentalis*). Evergreen tree native to eastern North America. A much smaller tree than the western red cedar. Height to 20m (65ft).



Left: The bark of a western red cedar develops greyish fibrous ridges that separate to leave reddish-brown fissures in between. With age the trunk of this species often becomes heavily fluted.

Bottom right: The bark of the white cedar is orange-brown with vertical ridges, here covered with algae.

Above: A male shoveler in breeding plumage. When swimming, shovelers have a distinctive appearance, lying noticeably low in the water. The stoutness of the neck is emphasized by the large head, ending in the great spatulate bill, held pointing slightly downwards as if a little too heavy for the bird.

SLIM PINTAIL AND SQUAT SHOVELER

The pintail is easy to recognise with its long, fine tail, as is the squat shoveler with its remarkably large bill. Both breed in Britain and Ireland, although breeding pintail are rare; and both populations are outnumbered in winter by visitors from northern USSR, coming in their thousands.

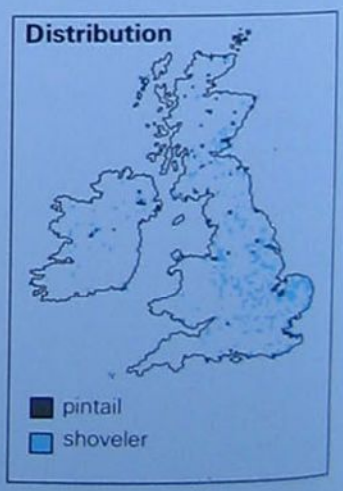
Of the 20 species of wild duck seen regularly at some time of the year in Britain and Ireland, seven belong to the genus *Anas*. These are mallard, teal, garganey, wigeon, gadwall, pintail and shoveler. Here we look at two of these, the pintail and the shoveler.

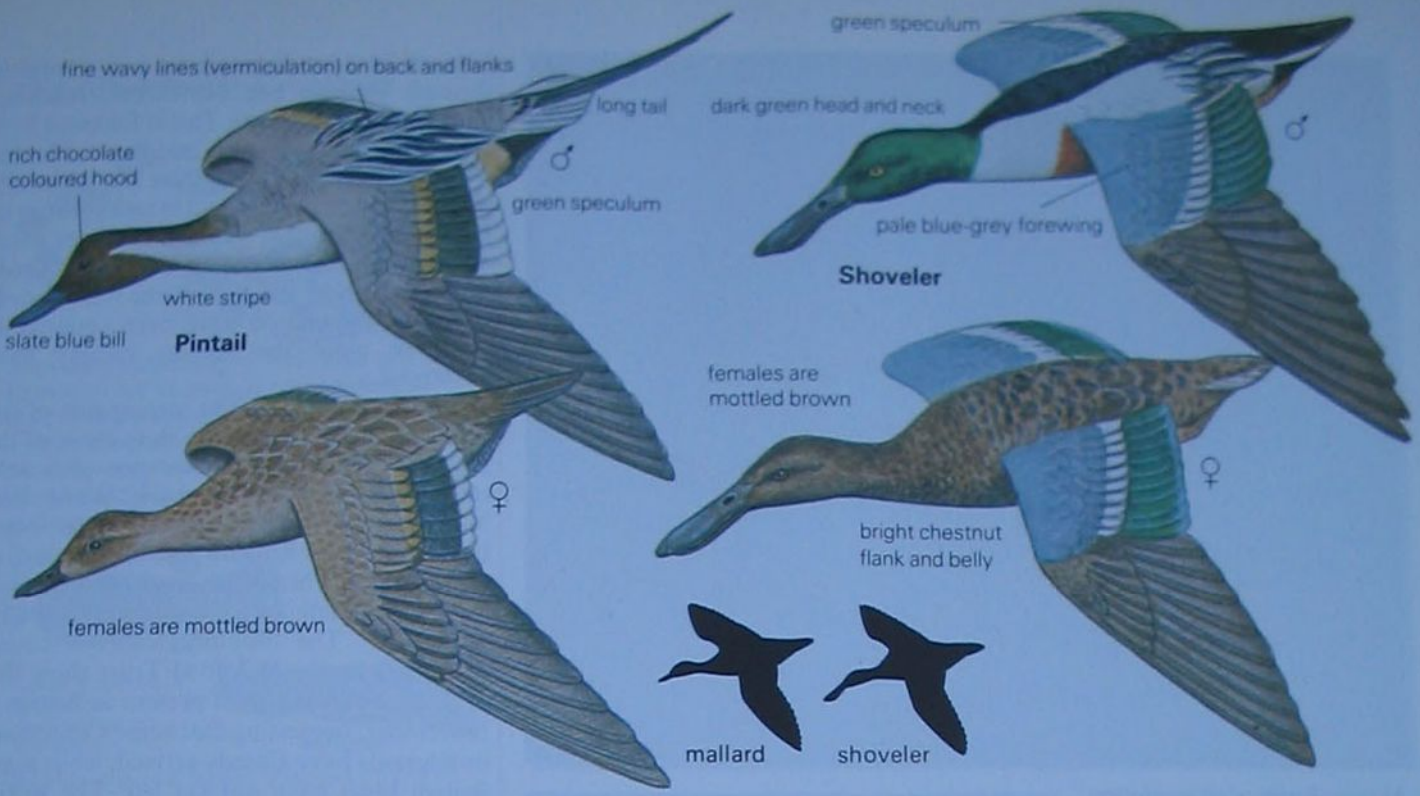
Measured from bill to tail tip, the pintail is the second longest of the group (after the mallard) at 56cm (22in), while the shoveler shares third place with the gadwall at 51cm (20in). As a breeding species the pintail is the rarest of the group, while the shoveler has the third largest population after the mallard and teal. Apart from the garganey, which is a summer visitor, the breeding populations of these ducks are reinforced by large numbers of birds migrating to Britain and Ireland from more northerly breeding grounds.

Pintail The slender body of the pintail is enhanced by its long thin neck and greatly elongated central tail feathers. The latter make up one fifth of its total length. The dark chocolate-brown colouring of the male's head continues down the back of the neck to the mantle (lower back). The front and sides of the neck are a bright and contrasting white which continues as a narrow streak up each side of the head. The underparts are also white, while the back and flanks are finely vermiculated (marked with tiny wavy stripes) in grey.

The squat, heavy-headed silhouette of the

Below: Both species breed in lowland areas with marshes and flood meadows.





shoveler is in direct contrast to the graceful pintail, though the male is not unattractive, having colourful plumage. The male is visible from a great distance thanks to its gleaming white chest. The head and neck are dark green, appearing almost black, while the flanks are a bright chestnut, further set off by a white patch between them and the black undertail coverts. The back is black but has two white stripes running from front to rear, one on each side. Female shoveler are a mottled brown all over, their bill and squat shape serving to identify them.

Breeding grounds The pintail and shoveler both breed in Britain, but the pintail is comparatively scarce, with probably no more than 50 pairs, while the shoveler, following a period of increase in recent years, is now estimated to total about 1000 pairs. The pintail has been found breeding in scattered small groups of one or two pairs, quite widely over northern England and Scotland; but many of the sites are only used once or twice in several years. Some of the more regular breeding places are to be found in East Anglia and north Kent. Here they nest in wet pastures, concealing their eggs under overhanging tussocks of grass, and never very far from shallow areas of fresh water.

Similar habitats are chosen by the shoveler, one of the major breeding sites for the species in Britain being on the Ouse Washes on the Norfolk/Cambridgeshire border. Here there has been a considerable increase in pairs, also reflected elsewhere in the country. In the 1950s there were probably no more than 50 pairs, but this had increased to about 100 by the 1960s, reaching a peak of over 300 in 1975, or perhaps a third of the total for Britain. Elsewhere there are few concentrations, but the species is widespread in all but the more upland areas of the country.

Winter numbers In winter the relative status of the two species is reversed. The pintail is much more common, with a regular peak of about 25,000 and perhaps occasionally as many as 30,000. The shoveler, on the other hand, rarely numbers much above 5000-7000, with an absolute peak of perhaps 10,000. A few years ago a peak of 5000 would have been unusual, but the increase noted in breeding birds has been reflected by an increase in wintering numbers, at least during the early part of the winter.

Pintail migration The great majority of the pintail wintering in north-west Europe breed in the northern part of the USSR. But this is only a small part of the total number of pintail migrating out of this area each autumn. Perhaps 75,000 winter in north-west Europe, compared to some 300,000 in the Mediterranean and Black Sea areas. Some of these even cross the Sahara to winter in Senegal and Niger, West Africa.

The pintail start to arrive in Britain and

Above: Recognition features of the birds in flight. The silhouettes show how different a shoveler looks from a mallard—chiefly because of the bill. Also, the shoveler looks as if its wings are set further back because the bill extends so far forward. The pintail has a slim body with a long tail. It also has a green, shiny area (a speculum) behind the forewing. The shoveler, on opening its wings, reveals a pale blue-grey forewing and behind it a green, white-edged speculum.

Below: A male pintail preens his back feathers, of which the remarkably long scapulars are clearly seen pointing outwards across the front of the wing.

Above: A group of wintering pintail stand in the safety of the ice on a pond. As in most duck species, the winter plumage is identical to the summer plumage. During late summer most duck species, including shoveler and pintail, enter an 'eclipse' phase of several weeks during which males take on the mottled brown colouring of the females. The pintail eclipse is from mid July to late September, after which the males resume their colourful appearance, as seen here.

Right: A female shoveler sits on her nest. The breeding habitat is uncut waterside meadowland, and this picture shows how suitable it is as cover for the shoveler.

Ireland in late September, and continue through October and November, reaching their peak in December. This is followed by a steady decline until the middle of March, when most of the migrants have left. Although pintail are quite widespread in small groups in Britain in winter, the great majority of them are concentrated on only a few sites. Indeed, as many as three-quarters of the total British wintering population have been counted at just one place–the Mersey estuary near Liverpool.

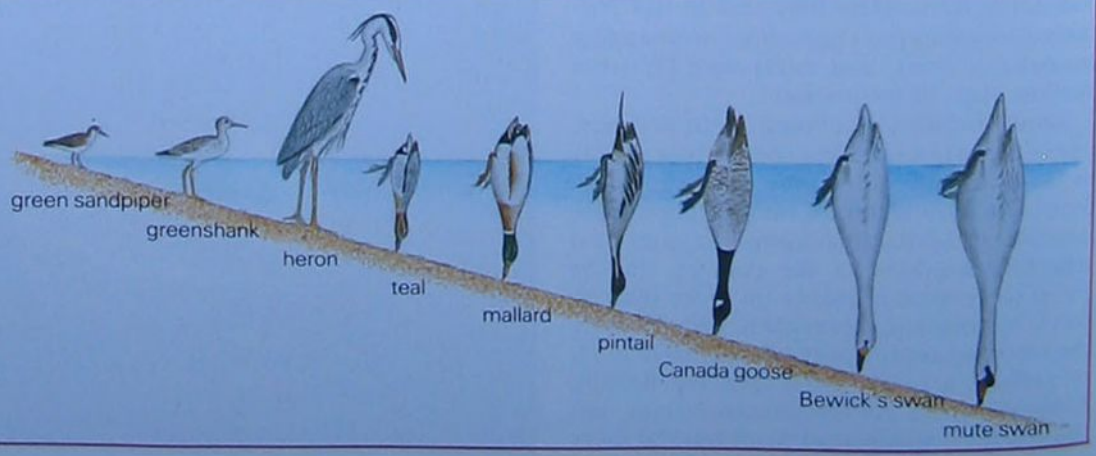
Shoveler migration The movements of the shoveler are more complex than those of the pintail because of the existence of a substantial British breeding stock. While these birds move away south for the winter, other birds come from Russian breeding grounds to replace them. The British stock seem to move away during late autumn, probably not until November. The monthly wildfowl counts organised by the Wildfowl Trust show that peak numbers are often present in Britain in November, suggesting that some Continental immigrants have already arrived, while many British birds have not yet left. The British shovelers generally go south into Spain and southern France, with a few crossing the Mediterranean to winter in North Africa. Many more birds come from further east to winter in the Mediterranean area, probably totalling some 150,000. The November peak in Britain has reached 9000, but 5000-7000 is more usual. During December, January and February, probably only the Russian immigrants are present in the country, and numbers fall to perhaps 4000-5000.

On one occasion in the 1960s there was a further peak in shoveler numbers in March and early April, and it was assumed that this represented both the Russian birds, not yet on their way back east, together with the British breeders already returned to their nesting areas. In recent years, however, this peak has failed to materialise, and it may be that the Russian birds are now leaving earlier, though the reasons why this might be so are not clear.

Changing sides These varying movements by different stocks of shoveler have been re-

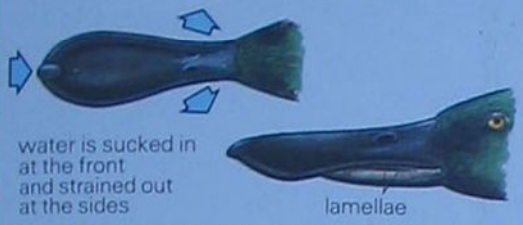
Reaching for the mud

Feeding in winter on estuaries and floods, and in summer on ponds, lakes and rivers, 'upending' species of water birds can each exploit waters of different depths. The duck with the longest reach is the pintail, followed by the mallard. Differences in upending depth allow many species to feed in the bottom mud without competing for the same sites.



The filter feeding method

Shovelers swimming in this close 'raft' formation are exploiting two sources of food that are suitable for straining through a filter: the plankton just below the surface, and any food items stirred up from below by the paddling feet of many shovelers as they swim round and round.



The shoveler is a highly adapted filter feeder. The sides of its enormous bill are thickly fringed with fine tooth-like lamellae, like the teeth of a comb. The bird sucks the water in through the tip of the bill, which is broadened out, so permitting a greater throughput, and then squirts it out through the sides, trapping food items in the lamellae.

vealed by marking the birds with leg rings. What has also been shown is that occasionally a bird joins the 'wrong' population. For example, there have been a few cases of shoveler ringed as young birds in Britain, being recovered in subsequent years in Russia. This has mostly occurred with males. What seems to happen is that the British-reared male meets an attractive Russian female shoveler, arriving in Britain for the winter; and instead of ignoring her and setting off on his own southerly migration, the male pairs up and then flies back to Russia with her during the following spring. A special term has been coined to describe this behaviour – abmigration.

How pintail feed The largest flocks of wintering pintail in Britain are found on estuaries, and on flooded marshes and pastures. Easily the biggest concentration is on the Mersey estuary near Liverpool, where a maximum of over 18,000 have been counted together. There are other important sites for pintail in the same part of Britain, particularly the Dee and Ribble estuaries, and on the freshwater pools of Martin Mere north of Southport. The natural foods of pintail are quite varied. They take small snails and other invertebrates from tidal mudflats. They also 'upend' in shallow fresh water and eat a great variety of seeds. In many areas, however, they 'flight' out (fly in formation) in the early morning to feed on nearby areas of farmland.

Here they glean spilt grain from harvested wheat and barley fields, and even pick up pieces of potatoes and sugar beet after the harvesting machines have been through.

The plankton specialist Shoveler rarely occur in Britain in flocks greater than 500. Most of the larger flocks are on reservoirs, for example those around London, and on flooded pastureland, such as the Ouse Washes, where many pairs breed. Shoveler pick up quite large seeds and insects in their bills, and frequently feed by picking and nibbling round the edges of pools and reservoirs.

However, while classed as 'dabbling' ducks, they have a unique feeding method. Their large bills are specially adapted for filter feeding, enabling them to exploit plankton, which other water birds are not able to use. Even so it takes a lot of feeding to gather enough to live on, and it is probably for this reason that, while small numbers of shoveler are often seen on lakes, reservoirs and gravel pits throughout Britain, large flocks of these birds are rare.

Above: A pair of shoveler, demonstrating the use of their specialised bills.

Shoveler (*Anas clypeata*). Breeding population of *c.* 1000 pairs; most of our wintering birds breed in northern USSR. 51cm (20in).

Pintail (*Anas acuta*). Small breeding population below 50 pairs; most of our wintering birds breed in northern USSR. 56cm (22in).

Below: A pintail upending. Not only do the different species of bottom-feeding waterbirds share the feeding grounds by each specialising in a particular depth; the male pintail can feed in deeper water than the female, thus reducing competition between the sexes within a flock.

Above: A black rat which was found near Kew Bridge, London. Today black rats are mainly confined to seaports.

THE OLD ENGLISH RAT IN A STEADY DECLINE

The steady decline of the black rat is one case which does not cause grief even among wildlife enthusiasts. Over the centuries it has carried plague and death on a massive scale, and it continues to do so in under-developed countries. Today in Britain it has to struggle hard for its existence.

Two species of rat occur in the British Isles, the brown or common rat, and the black rat. The black rat was introduced during the 11th or 12th century, and for 600 years was the common rat of the British countryside. When the more versatile brown rat was introduced in the late 1720s, the black rat was often referred to as the 'old English rat' to differentiate between the two species. Today the black rat is mainly confined to major ports such as London, Liverpool, Aberdeen and Southampton, a few city centres (including London's Oxford Street), the island of Lundy off the coast of Devon, and the Channel Isles. Its population is declining, however.

Arrival in Britain Traditionally the black rat arrived in the baggage of crusaders during the Middle Ages. Its original home was around Thailand where, several thousand years ago, it co-existed with early man, sharing his newly emerging settlements and eating his food. As trade routes were opened up, the rat followed, eventually reaching western Europe. By the 13th century, as the legend of the Pied Piper of Hamelin reminds us, black rats were firmly established in Europe.

The first black rats to arrive in this country thrived in the towns, villages and isolated farms of the period. By the late 13th century black rats were becoming a considerable nuisance in England, and attempts were made to eradicate them. According to Chaucer's

BLACK RAT (SHIP RAT, ROOF RAT, ALEXANDRINE RAT) (*Rattus rattus*)
Size Head and body 16-23cm (6½-9in), plus tail 18-25cm (7-10in). Adult weight 15-20gm (½-7oz).
Colour Very variable. *Rattus rattus rattus* is pure black above, black or dark grey beneath; *R.r.alexandrinus* is grey-brown above, grey beneath; *R.r.frugivorus* is brown above, white or cream beneath. The three forms interbreed.
Breeding season All year, especially in summer.
Gestation 21 days.
No of young 5-10, average 7. 27 have been recorded.
Lifespan Maximum 18 months, most die in first winter.
Food Omnivorous. Fruit, vegetables, cereals.
Predators Man, domestic cat.

Pardoner's Tale, rat poison was available from apothecaries. In some areas 'ratoners' or ratcatchers were employed, and rats were sold in villages for a farthing each.

Black death The black rat is the main host of the flea that transmits the bacillus causing bubonic plague, and outbreaks of 'Black Death', as it was known, followed the rat's progress westwards. It reached Britain in 1348 and about one third of the population died. It reappeared several times and the last epidemic, known as the Great Plague, occurred in 1665, killing many thousands of people. The disease was destroyed in London in the Great Fire of 1666.

Medieval physicians, who knew nothing of germs, tried to treat plague symptoms–swellings, boils, tumours and delirium–by bleeding or fasting, both of which had a weakening effect and made the sufferer even more likely to die. Today plague still occurs, especially in under-developed areas of the world with poor housing and hygiene. A vaccine can now provide partial immunisation and the disease can be treated with drugs.

Three forms Colouring is an unreliable way to distinguish rats: some brown rats are almost black, while black rats have a variety of brown forms. There are three sub-species of black rat in Britain: *Rattus rattus rattus* has a black coat with a black or dark grey underside; the Alexandrine rat (*R.r.alexandrinus*) is brown above and grey beneath; and the tree or roof rat (*R.r.frugivorus*) is brown above and white or cream beneath. They can live together and interbreed, resulting in many colour gradations.

High life In the tropics and sub-tropics black rats often live in palm trees, fruit plantations and bushes. In Britain, too, they are less terrestrial than brown rats. Around seaports they are commonly found in warehouses and other waterside buildings where they inhabit rafters and wall cavities on the upper floors, while brown rats usually live in basements or in burrows outside.

Black rats are expert climbers, capable of ascending vertical wires, cables, walls and pipes, provided the surface is not too smooth. They cross between buildings and over streets along overhead wires and trees. They are more agile than brown rats, and move more rapidly, sprinting along, then pausing at a vantage point on a rafter or ledge for a moment before running off again.

Where rats have regular runways and their fur brushes against a wall or other object they leave black greasy smears. 'Loop' smears, semi-circular marks where the rats have had to swing under a rafter or pipe, are especially characteristic. Other signs of their presence are gnawed cables and pipes, a musty odour and damage to stored goods. They leave droppings anywhere, particularly at their feeding places. In grain stores droppings contaminate large quantities of food.

Black rats eat almost anything of nutritional value. They are more vegetarian than brown rats, with a distinct preference for fruit. They forage within a range of 80-90m (262-295ft) for food, both inside and outside buildings, although some males may move farther afield. They are mainly nocturnal but some individuals, usually the less dominant, may forage in daylight.

Social life Black rats live in groups of up to several hundred animals. There are dominant and subordinate males, and females and juveniles in each group. Individuals recognise each other by smell, and within small colonies the social positions are well defined and there is little aggression. A newcomer is likely to be attacked. If he ignores the dominant

Rat kings There is no adequate explanation for 'rat kings'–dead rats found with their tails mysteriously and elaborately knotted together, and recorded throughout the world over hundreds of years. Have the tails become soaked with urine and then frozen? Have the rats been frightened, tried to escape, and got knotted together? Or have they brought something sticky into the nest?

Above: Black rats are susceptible to bubonic plague which is spread by the rat flea (*Xenopsylla cheopis*). The flea feeds on an infected rat, then moves to another rat or human, so transmitting the disease. Bubonic plague is named after the swellings or 'buboes' of the lymph nodes in the armpits and groin. Today it is treated with drugs.

Left: The tree or roof rat, a subspecies of the black rat, most closely resembles the wild subspecies from which the other forms have arisen.

Below: A black rat grooming its tail.

rat's threat postures – an arching of the back with all four limbs extended and the flank turned towards the opponent, followed by mincing movements around the newcomer – the resident leaps at him and bites the ears, legs or tail.

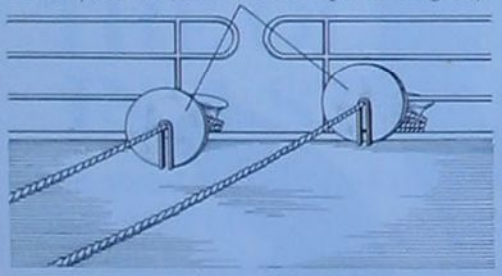
Boxing, in which both animals stand on their hind legs and strike with their paws, sometimes occurs in the interval between more violent bouts of fighting. Fights are always between individuals, but a stranger may be attacked by a number of resident males in succession until it is ejected. Excitement can spread throughout the colony until all the animals are leaping wildly about. In larger colonies the social order occasionally breaks down and intruders may no longer be recognised.

Prolific breeders Black rats breed all year, reaching a peak in summer and sometimes in autumn. The female builds the nest with any available soft material in a wall cavity, among rafters, below floorboards or behind pipes. There are three to five litters of five to ten young each year. The male's involvement in rearing the young is actively discouraged by the female, for cannibalism by male rats is common.

The young are sexually mature at three or four months old, but by then many will have died from predation, poisoning and other causes. Man is the chief predator, but the domestic cat also catches rats. Few rats live

Ships' rats

Cones prevent rats from entering or leaving ship



More than 90% of rats found aboard ships are black rats. They boarded ships among stores, or climbed mooring ropes of ships in harbour and were unintentionally transported throughout the world. The vessels of explorers such as Captain Cook were heavily infested with black rats. Human populations have been devastated by them: in 1686, the 30 inhabitants of North Rona, between the Hebrides and the Shetlands, were eaten out of house and home by black rats that came ashore from a shipwreck. The entire population starved to death, and the rats soon after. There are now compulsory regulations to ensure that rat infestation on ships is minimised. Port Health Authorities are required to issue either 'de-ratting' or 'exemption' certificates, depending on whether a ship requires fumigation or is free from rats; permanent baits are common.

longer than 18 months, and the annual mortality rate is 91-97%.

Black rats have highly developed hearing and scurry into hiding if they hear an unfamiliar sound. Their sense of smell is also acute, but their eyesight is rather poor. Both species of rat tend to keep to familiar areas and runways, but black rats do not show such a marked avoidance of strange objects, such as traps, placed in their territory. Brown rats and house mice tend to avoid unfamiliar objects for 48 hours or more.

The black rat's decline By 1845 the black rat was thought almost to have vanished from London, and a ratcatcher of St Giles was able to sell specimens to naturalists from a stall in Trafalgar Square for three guineas each. In fact the rat was still common in some areas, and it is probable that observers were mistaking the brown forms – the roof rat and the Alexandrine rat – for brown rats.

It was not until this century that the black rat population began to decline rapidly. This is most likely due to our increased standards of hygiene and improved buildings, so that it is hard for rats to find warm homes. Where they do occur they are prime targets for control, and every effort is made to prevent them arriving from abroad.

A number of theories directly implicate the brown rat as a cause of the decline. One belief – that the brown rat kills the black and takes its territory – is certainly untrue. While it is a fact that in a direct confrontation between the species the heavier and more aggressive brown rat almost certainly wins, such an event seldom occurs. Both species live in and around the same buildings and there is often a considerable overlap in their ranges, but as brown rats often nest in the lower parts of buildings, or in burrows outside, and the black rat nests within the framework and in the upper stories, confrontation and competition is lessened.

Whatever the reason for the decline, it is likely to continue, and although black rats remain in several localities, even in small numbers and despite the precautions that allow little new blood to arrive from abroad, the future for the species looks very bleak.

Above: Although rats are generally considered to be dirty and unhygienic, frequenting sewers and other insanitary places, the black rat is cleaner in its feeding habits than the brown, and spends much time meticulously grooming its fur, tail and paws.

Left: Jack Black, Her Majesty's Ratcatcher, around 1850.

Below: A black rat with young. Rats have three to five litters a year.

FLOWERS: WHAT'S IN A NAME?

When you sniff at your freesias, water your tomatoes or drink your tea, do you ever wonder where all the names of plants come from?

Ever since man has needed to communicate the details of the world around him he has given shorthand descriptions – names – to plants so that he could quickly convey to others information, such as whether a particular plant is edible, where it can be found and what it looks like.

These names were usually based on the most distinctive features of the plant. A name may reflect some features of its general appearance, its flower, fruit or seed colour, or it may allude to its place of origin or its habitat. It can also be named for its chemical or medicinal properties, after the discoverer or even after his friends or enemies.

Classical names Many plant names go back to Graeco-Roman times, with some deriving from even more ancient civilisations. Almost all the scientific names of plants (the so-called Latin names) derive from Latin or Greek. On top of that each nation has, over many centuries, developed its own folk nomenclature used by lay people. Many of these names also have classical origins.

The tomato, for instance, was thought for a long time to be poisonous and it was grown only for its ornamental value. This is reflected in its scientific name, *Lycopersicon*, which comes from a combination of the Greek words 'lykos', meaning wolf, and 'persikon', meaning peach. Hence wolf-peach: a fruit to be avoided.

Chinese has provided us with a few plant names. Those who refer to their tea as 'char' might be surprised to learn that the word comes from the Chinese for tea, 'tcha'. When latinised it becomes *Thea*, and *Thea sinensis* is the plant species that provides the leaves for China tea (the specific name *sinensis* means coming from China).

Medicinal associations Many plants are named because of their medicinal uses. Until the end of the 19th century botany was taught to students of medicine, and this close connection between the two subjects is often reflected in a name.

One of the most important medicinal plants is opium, a name that comes from the Greek 'opion' or 'opos', which means sap. This refers to the sap that is collected from the mature

Above: Many plants are named after some striking feature in their appearance. For example, the word 'geranium' comes from the Greek 'geranos', meaning crane, a reference to the plant's beak-like stigmas and swollen seed cases which, after the petals fall, resemble the head and beak of a crane.

Left: Generic names of plants often derive from the botanist who discovered it or first classified it. Linnaeus named his favourite flower, the twin-flower (*Linnaea borealis*) after himself. This plant is common in Linnaeus's native Sweden and is also found, though rarely, in woods and shady rocky places in Scotland.

poppy capsules and converted into the drug opium. Its scientific name, *Papaver somniferum*, means the sleep-inducing poppy.

Superstition and religious belief influenced the names of many medicinal plants. During the Middle Ages, it was believed that God put His mark on various plants as a signature to their medicinal properties, a theory known as the Doctrine of Signs. For example, hepatica (from the Greek 'hepar', meaning liver) could be relied upon to cure liver ailments because its leaves have the shape of a human liver. Similarly, hound's tongue leaves were reported variously as curing illnesses in dogs or as an antidote for dog bites because they resembled a dog's tongue.

Colourful names One of the most obvious characteristics of a flower is its colour, and many plant names refer to this property, often to distinguish between two otherwise very similar species, for example the white clover and the red clover.

Less obvious are the references to colour in a plant's scientific name. White plants frequently have the name *alba* (Latin for white), as in *Silene alba*, the white campion, which has white petals. Black is indicated by either the Latin *nigrum* in specific names or by the Greek *melano* in generic names. Thus blackcurrant is *Ribes nigrum* and ebony is *Melanoxylon*. Many other colours can be found hidden away in scientific names, for example red is represented by *ruber* or *roseus*, and green by *virens*, *chloro-* or *viridis*.

Personal names In the 16th, 17th and 18th centuries, when it was customary for all scientific literature to be written in Latin, scholars even used to latinise their own names. In this latinised form, many famous botanist are commemorated in plant names. For example *Freesia* is named after the German physician, Freese, and *Dahlia* after the Swedish botanist, Dahl.

However, it was not always a great honour to have a plant named after you. The great 18th century botanist, Linnaeus, hated his rivals, in particular a man called Johann Siegesbeck from St Petersburg. Linnaeus despised this man so much that he named a weed after him, *Siegesbeckia orientalis*.

Right: The specific name of a plant (the second of its two scientific names) often signifies some characteristic colour, usually of its flowers or fruits. Common examples include *nigrum* (black), *argenteum* (silver), *purpureum* (purple), *album* (white), *cyanus* (blue), *flavum* (yellow), *viridis*, or *virens* (green) and *sanguineum* (blood-red), with *ruber* or *rosea* being used for less intense red colours.

Right: The white spots on the leaves of lungwort led people to believe that the plant would cure 'ulcers of the lung'.

Below: Hemp (*Cannabis sativa*) is the source of the drug hashish. The words 'hashish' and 'assassin' derive from the same source: the Arab fanatic, Hasan-ibn-al-Sabbah, whose wild followers, the Hashishim, used to assassinate people, spurred on by the promise of hashish afterwards.

A LANDSCAPE RECLAIMED

The vast, flat expanses of Romney Marsh, which include the extraordinary shingle spits of Dungeness, are fascinating to botanist and birdwatcher alike for their range and variety of interesting and rare species.

Above: The Isle of Oxney on Romney Marsh, with typical flat chequerboard fields and isolated clumps of trees. The word 'isle' belongs to another era, when this part of the Marsh may have been surrounded by water.

Romney Marsh – known locally (for its remoteness) as 'the fifth quarter of the globe' – lies astride the Kent/Sussex border, behind Dungeness. On the Ordnance Survey maps of the area, improbable names like the Isle of Oxney, given to hummocks some miles from the sea, give a clue that the origins of this area may not be totally straightforward.

Today, Romney Marsh is a colloquial collective title for Dungeness and several areas of 'marshland' – Romney, Walland and Denge marshes and the New Romney Levels – totalling some 20,000 hectares (50,000 acres). Much of the area south and east of the Royal Military Canal is now marsh in name only, for although it is criss-crossed by a complicated system of ditches and dykes running into larger drainage channels, the water level in these ditches is low, and typical marshland plants, such as the common reed *Phragmites*, are restricted to narrow fringes.

Despite this, and despite the recent presence of holiday camps and other signs of human recreation along its sea coast, much of the Marsh remains a remote place. The landscape is flat with isolated villages and homesteads connected by narrow roads which rarely seem to head in any practical direction, often taking you at right angles to your destination. Villages and isolated farms alike shelter behind windbreaks, often clusters of

willows, and the most prominent features are a series of churches, typically situated on a slight mound, and the parallel lines of massive pylons taking electricity from the Dungeness nuclear power stations and feeding it into the national grid.

Dungeness itself, the most extensive spread of shingle in Britain, forms a gigantic triangular projection, pointing south-east out into the Channel. This great wedge of pebbles is a complex series of shingle spits, behind which, over thousands of years, Romney Marsh has formed as land reclaimed from the sea – in part naturally and in part deliberately engineered by man.

Birds, agriculture and smuggling It is difficult to conjecture what Romney Marsh would have held to fascinate naturalists several hundred years ago. However, it would seem safe to assume that, from its proximity to the Continent, and from occasional recent breeding records in the few genuine wetland areas remaining of such birds as the black tern, black-necked grebe and marsh harrier, it would have held rich populations of marshland birds.

Above: One of the unusual plants to be seen on the shingle at Dungeness is the prickly sea holly.

Left: A lapwing guards its precious clutch of eggs. Hordes of these attractive birds can be seen on Romney Marsh in winter, along with equally large numbers of golden plover – they are attracted by the wireworms, leatherjackets, slugs, snails and worms hidden beneath the marshy fields.

Below: Romney Marsh was once famed for its fields of grazing sheep, but today immense expanses of such crops as oilseed rape (shown here) hold sway.

Until recently the Marsh was renowned for its grasslands and the sheep that grazed on them (including a longwool breed that took its name from the Marsh itself), but today arable agriculture holds sway, and the immense fields of potatoes, peas, oilseed rape and strawberries have little to interest the ornithologist, or indeed any naturalist. Scenically, the other newcomer to local farming, the bulb fields, do provide added attraction, but it is to the remaining grazing land during the winter months that the birdwatcher turns his attention. Among the hordes of golden plover and lapwing can be seen such interesting birds as bean geese and wild swans, short-eared owls and rough-legged buzzards.

The history books can tell us something of the edge of the Marsh – the old cliff coastline still visible stretching from Lydd through Appledore to Rye. Not surprisingly, Romney Marsh has a long history of involvement with wreckers and particularly with smuggling, and we know that during the reign of Charles I (1625-49) these old cliffs were covered in dense woodland, a fragment of which still remains at Lympne. In these woods bands of smugglers took refuge from soldiers. Eventually the smuggling problem became so severe that the woodland was felled to eliminate the hiding places, and several heronries (the birds enjoyed the rich feeding from the marsh ditches) were destroyed in the process. Those ditches that remain still hold plenty of eels and in several places colonies of edible and marsh frogs flourish noisily.

The shingle at Dungeness The 20th century naturalist – geologist, botanist, entomologist or ornithologist – is primarily drawn, in all the vast expanse of Romney Marsh, to Dungeness. It is a habitat of surprises. Look inland, and shingle stretches as far as the eye can see to Lydd, some miles away. The shingle, even far from the sea, still lies in ridges and valleys, the ridges only a few feet high but, in

their fan formation, clearly showing a succession of hundreds of former coastlines. On the steeply shelving pebble beach at the point, large ships cut astonishingly close inshore, clear indication of the depth of water and a marked contrast to the sandy bays at Camber, to the south, where the bather must walk out to sea for hundreds of yards before the water even comes over his knees.

The presence of this deep water channel, and the out-jutting of the ness itself, make this a prime place for seabird movements. At all times there are some seabirds here, but at peak migration times in spring and autumn, their movements can be most spectacular. Divers and grebes, various gulls and terns, and the occasional fulmar and gannet are expected, but flocks of bar-tailed godwits in their superb cinnamon-coloured spring plumage, or of Brent geese, or even of pomarine skuas in early May, definitely give extra interest.

Skeins of common scoter, one of the sea ducks, passing in line astern low over the water, very occasionally contain a velvet scoter, conspicuous because of the bold white patch on its wing, but otherwise a black or dark brown bird like its relative. It is amazing to speculate on just what has changed since the end of the 19th century, because then the local bird books reported on flocks of *thousands* of velvet scoter in Rye Bay.

Nesting sites and migration routes The situation on Romney Marsh has, however, changed much since the days when so many velevet scoter could be seen. To the disinterested eye, the Dungeness landscape could appear grotesque–a mixture of wheel-less wooden railway carriages converted to fishermen's cottages just sitting on the shingle, with some ugly cement buildings left as relics of the War, the whole dominated by the vast and inelegant bulk of the power station, humming purposefully and occasionally emitting a puff of steam. The atmosphere is one of massive industry surrounded by dereliction, with a classical old lighthouse and a new-fangled, top-heavy modern light a short distance seaward–erected, you could imagine, as exclamation marks to emphasise the flatness of the shingle.

Above: A marsh frog with inflated vocal sacs (the small bubble-like swellings on each side of the frog's head). This attractive species, introduced to Britain in 1934-35, flourishes in colonies all over Romney Marsh.

Below: Romney Marsh once held several heronries, but these were eliminated when much of the woodland was felled to prevent smugglers from hiding in it. Now only the odd solitary heron can be seen, fishing for eels.

The power station, however, provides nesting sites on this flatness–windowsills for cliff-nesting fulmars and crevices for black redstarts. But more important, its cooling water enters the sea just offshore, creating an area of turbulence and warmth that brings numerous food items to the surface in a continuing supply. Known familiarly as 'the patch', this draws gulls and terns of all sorts, including rarities like the little gull and the roseate tern, within easy binocular range of birdwatchers sitting on the shingle or ensconced in the sea-watching Homes hide.

Speciality birdwatching The Homes hide is the property of Dungeness Bird Observatory, which maintains residential accommodation just inland. Here migrant birds are counted and some are trapped for ringing since, for land birds as well as for sea birds, Dungeness is an important area. Partly because of its shape and partly because of its position and proximity to the Continent, Dungeness sees a regular traffic of migrants, often in tremendous numbers, in spring and autumn. There is little that can remind the birdwatcher so forcibly of the hazards that birds face on migration than to see them approach the shore, low over the waves, then drop exhausted into the bushes a few hundred yards inland, or to see the bushes suddenly fill with thrushes and blackbirds late in the autumn when a sudden change from fine weather to a

sky overcast with rain has the birds tumbling out of the skies in search of shelter. Many of these birds are our regular summer visitors – the willow warblers, whitethroats and swallows for instance – but other exceedingly exotic strays, birds far from their normal homes, also appear. These may well include such species as the ortolan bunting and the tawny pipit.

Little terns and ringed plovers nest on the shingle, and so, years ago, did Kentish plovers. More recently, stone curlews ceased to breed, but these losses are more than compensated for by the birds that appear on the RSPB reserve a short distance inland. Based on islands, lakes and feeding areas carefully planned during the process of gravel extraction for building purposes, the reserve offers a wide variety of habitats and tempts many birds, among them some of the more exciting migrant waders, such as the Terek sandpiper which has flown all the way from Arctic Russia.

Plants of the shingle At first glance, the plant life seems scanty and rather dull – and no wonder, so poor a footing does the shingle offer. There are numerous mosses and lichens, and many ridges are clad in stunted broom (often draped with the parasite dodder), blackthorn and wood sage.

Nearer the sea you may well see one or two of the special plants of the area. Some are spectacular, like the yellow horned poppy, the elegant sea holly and the flabby (but edible) sea kale. English stonecrop flourishes on the shingle, and further inland in swampy hollows sallows thrive. On some of the drier, grassy stretches near the disused railway line even an orchid finds a foothold; this is the spiral flowered lady's tresses, which is only a few inches high.

Above: Sheep and cattle grazing on the wide, flat expanses of Romney Marsh near Appledore.

Left: One of the more exciting finds on the shingle at Dungeness – the attractive yellow horned poppy.

Below left: Arising as if in the middle of nowhere – one of Romney Marsh's small, isolated churches. Typically, these churches are sited on a slight mound.

The Cinque Ports

Inevitably associated with Romney Marsh, the Cinque Ports are of Norman origin. The original 'cinque' or five were Hastings, Romney, Hythe, Dover and Sandwich, to which were later added Rye and Winchelsea and several lesser status ports that included Lydd, Folkestone and Pevensey. These ports were founded to provide men, ships and harbours for the navy of the time, and of course were also developed as commercial shipping centres. They had their heyday in the 14th century, after which time changes in the coastline, silting up, and great storms reduced those associated with Romney Marsh to minor importance by the 15th century, although Folkestone and Dover are still active today.

CARNIVOROUS WATER BEETLES

The great diving water beetle is a surprisingly savage insect. Besides possessing a lethal defensive mechanism which is capable of killing a frog, it is also a fierce predator, feeding on any small water animals from insects to fishes.

Above: Great diving water beetles keep a store of air under their elytra which makes them extremely light. To remain under water they must either swim or hold on to aquatic plants.

Opposite: When the larva of the great diving water beetle feeds on a tadpole it injects digestive juices into the victim, liquefying it within a matter of minutes. The predator then draws back the liquid and discards the tadpole's empty skin.

Anyone interested in pond-life is sure to have come across the great diving water beetle (*Dytiscus marginalis*) – probably the best known and studied of all water beetles. This species is a common insect in ponds and slow rivers, but can also be kept easily in aquariums where it may survive for two or three years.

Water beetle anatomy The oval body of the great diving water beetle is dark greenish-brown above and yellow around the margins of the thorax and the elytra (wing cases), and underneath. The eyes, large and each possessing about 9000 facets, are situated at the sides of the head so they can see easily above and below. The antennae are thread-like and not particularly conspicuous.

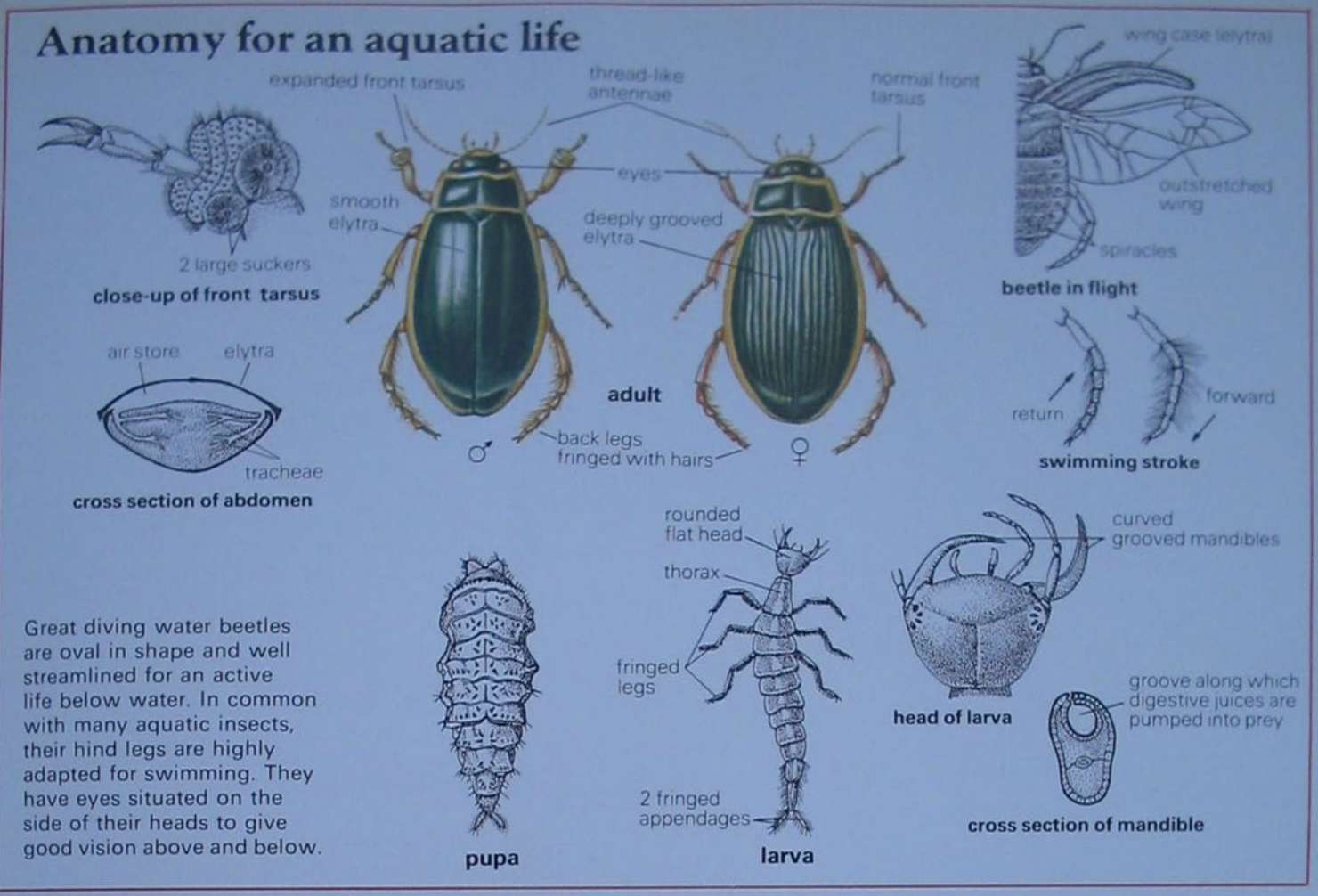
It is not difficult to distinguish the sexes – the male has smooth elytra and expanded front tarsi, while the female has deeply grooved elytra and normal front tarsi. On the male's front tarsi the first three segments are enlarged to form a conspicuous circular disc fringed with stiff hairs. On the underside of the disc there are rows of small, close-set suckers which, when moistened with a sticky fluid, become adhesive. These organs are capable of supporting more than 13 times the beetle's own weight, and are chiefly used to hold the female during mating. The two final segments of the tarsi are normal and end in the usual pair of claws.

Rowing and flying In common with many water-dwelling insects the great diving water beetle's hind legs are highly adapted for swimming. The tibiae and tarsi are fringed with long stiff hairs which spread out during the swimming stroke, so maximising the 'pull', and become flattened during the return stroke, thus minimising resistance to the water.

This 'feathering', as rowers would call it, is brought about by a slight but automatic rotation of the tarsus as it moves through the water, so that its broad face is presented during the swimming stroke and its edge during the return. The two hind legs work together and are most efficient rowing organs.

These beetles are not entirely restricted to an underwater existence. They fly readily from pond to pond, usually at night, and often turn up in garden ponds. Sometimes they are confused by the reflection of moonlight and land on greenhouses and glass frames. Their membranous flying wings are folded flat on top of the abdomen and covered by the elytra.

Carnivorous feeders Great diving water beetles do not hibernate, but swim about and feed in all but the coldest weather. They are extremely rapacious and feed on any small



creatures they can catch—insects, molluscs, tadpoles and even small fish. They tear the prey up with their strong biting jaws and swallow the pieces, finally digesting them in their stomachs.

If you keep these beetles in an aquarium you will find they feed readily on pieces of meat or worms, but make sure you do not give them too much food. The surplus will decay and cause the water to turn foul.

Breathing and defence You can tell if a pond contains great diving water beetles by sitting quietly and waiting for them to come up for air. They have an extremely efficient breathing system comprising two rows of spiracles (air vents) arranged along the sides of the abdomen. The last two pairs of spiracles are much larger than the rest; when at the water surface the beetles raise their elytra slightly so that these large spiracles can take in air directly. The other spiracles use the air which is stored under the elytra.

The defensive powers of the great diving water beetle are no less impressive than its breathing system. In addition to a pair of sharp spikes on the beetle's underside, it can produce an unpleasant-smelling nerve poison which is sufficiently lethal to kill a frog. This deadly fluid emanates from glands on the thorax.

If you catch any water beetles try not to touch them. They are best tipped straight from the net into a jar of water or into a box filled with wet water weed.

Life cycle In March and April the females lay their eggs singly in slits which they cut in water plant stems with ovipositors equipped with extremely sharp blades. Individual adult females lay eggs at the same time each year. The eggs are rather large—up to 7mm ($\frac{1}{4}$in) long—and hatch in about three weeks.

The larva is quite unlike the adult beetle except that it is even more rapacious, feeding

Below: Great diving water beetle viewed from the underside. Should you catch one of these in a pond net, handle it carefully—not because of its jaws, which it seldom uses, but because of the sharp spikes on its underside, clearly visible in this picture.

Above: A good view of the small diving water beetle, (*Acilius sulcatus*) with an air bubble at the rear of its abdomen. This species is commonly found in ponds, particularly sandy or gravelly ones, although it is only active from March to November. In many ways it is similar to the great diving water beetle, but it is hardly more than half its size, at 16-18mm ($\frac{5}{8}$-$\frac{3}{4}$in) long, and rather paler in colour. While the male has smooth elytra (wing cases) and enlarged front tarsi, the female has strongly ridged elytra and normal front tarsi. The larva is just as rapacious as that of *Dytiscus marginalis*, feeding on small aquatic creatures throughout summer. When fully grown it is smaller than *D. marginalis* with a narrow thorax, long neck and small head – almost shrimp-like in form. The fully grown larva builds cells in mud at the water's edge where it pupates, emerging as an adult before the winter sets in.

on any living thing it can catch, including its own brethren. It is elongated with a rounded flat head carrying slender, pointed mandibles. Its three pairs of legs are long and fringed with hairs, so that they work efficiently as oars, enabling the larva to move slowly through the water. It can also make a sudden spring by active, snake-like body movements.

The end of the larva's abdomen narrows and has two small hair-fringed appendages. As the larva is lighter than water it rises, tail first, if it is not holding on to any vegetation. This occurs when the larva's air stores need replenishing – the tail appendages break the surface film so the two larger spiracles at the tail end can take in fresh air while the larva hangs from the surface. These two spiracles, the only open ones it possesses, communicate with two longitudinal air tubes in its body, which are unusually wide to allow for air storage.

Rapacious larva One of the larva's most interesting features is its jaws, which have a fine, almost closed groove along the inner edge. When the larva seizes the prey with its jaws it injects digestive juices along the grooves into the victim. The prey's tissues are then rapidly digested, and the larva draws in the resulting fluid using a pump in its throat. Only the victim's empty skin remains.

In about six to eight weeks the larva is fully fed. At this stage it leaves the water and burrows into damp soil near the water's edge, making a roundish cell to pupate in.

In summer the adult beetle emerges from its pupa after only two to three weeks, but if the larva does not pupate until autumn, it will not emerge as an adult until spring.

Other species Six species of *Dytiscus* are found in Britain, but only *Dytiscus marginalis* is common everywhere. Of the remainder, *Dytiscus semisculatus*, a smaller species is not uncommon, but is more restricted to running water. *Dytiscus circumflexus* is much the same size as *D. marginalis* but has black markings on a yellow underside.

There are more than 100 other carnivorous water beetles in Britain – two of the more common species are worth mentioning. *Colymbetes fuscus* 17mm ($\frac{5}{8}$in) long and yellowish-brown in colour, is found in almost any pond with a muddy bottom. Its larvae are similar to those of *D. marginalis* except that the mandibles are shorter and the thorax broader. This species overwinters as a larva and does not pupate until spring.

Hygrobia hermanni is known commonly as the screech beetle because of the way it stridulates when picked up. It does this by rubbing the tip of its abdomen against a file on the underside of the elytra. The adult is reddish yellow in colour and can be found in southern England and Ireland.

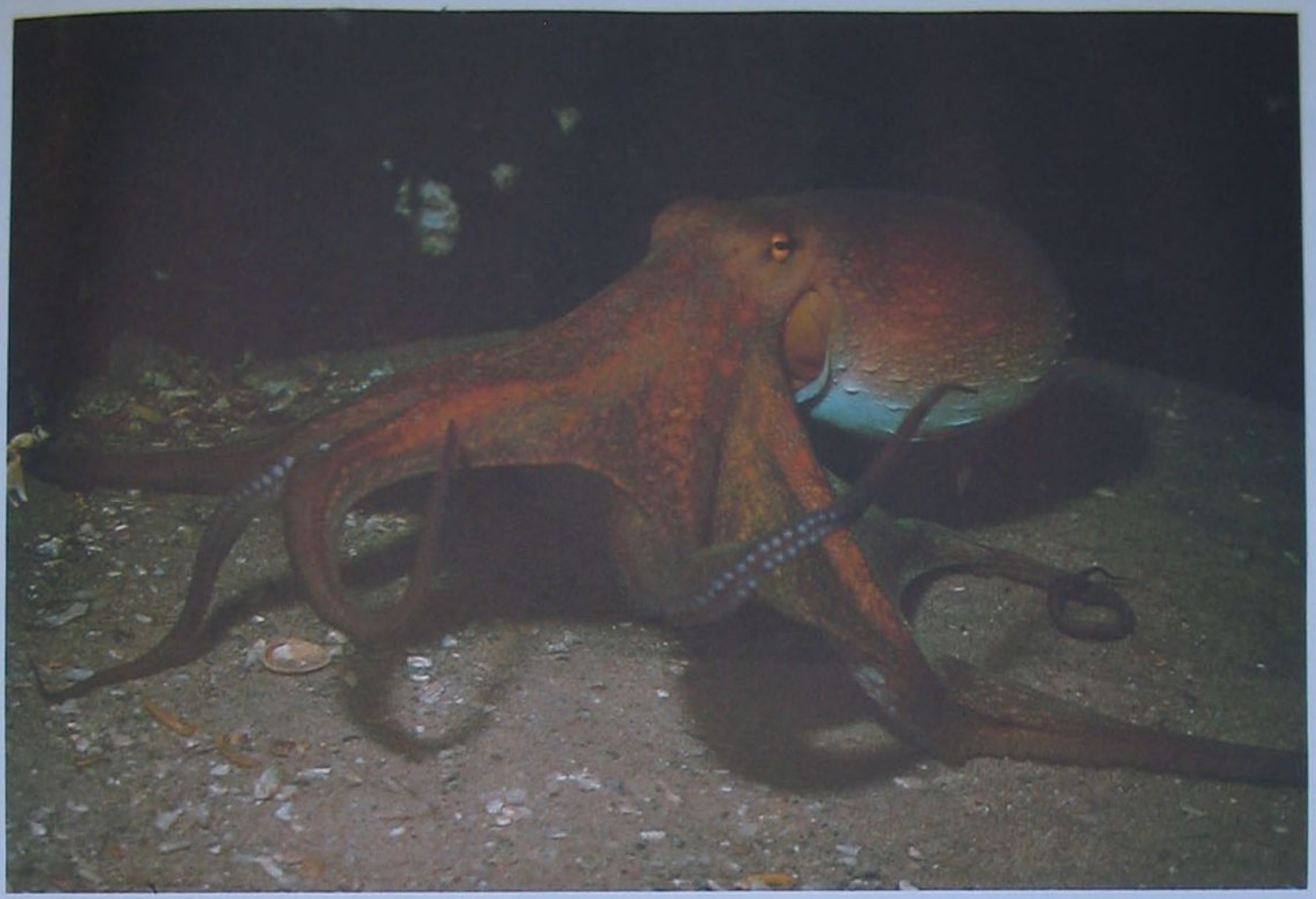
Unlike other species its larva does not come to the water surface; it breathes by means of gills along the lower side of the abdomen.

Left: *Dytiscus semisculatus*. 2.5-3cm (1-1$\frac{1}{4}$in) long. Common in running water.

Right: *Dytiscus circumflexus*. 3.8cm (1$\frac{1}{2}$in) long. Uncommon, ponds and canals.

Left: *Colymbetes fuscus*. 17mm ($\frac{5}{8}$in) long. Common in ponds with muddy bottoms.

Right: **Screech beetle** (*Hygrobia hermanni*). 8-10mm ($\frac{3}{8}$in) long. Ditches and ponds.



OCTOPUSES: MANY ARMED MOLLUSCS

The two species of these curious molluscs most likely to be encountered around Britain are the common octopus and the lesser octopus. Both hide away for most of the day but emerge to probe for prey during the hours of darkness.

Above: The common octopus (*Octopus vulgaris*) is the species most often found in British waters. It can be distinguished from the lesser octopus (*Eledone cirrosa*) by the two rows of suckers along each arm and by its rough-textured skin. Although it is less widely distributed, the common octopus is the one most likely to be seen as it lives in shallower waters than the lesser octopus.

Octopuses are molluscs, placed in the class Cephalopoda – the same class as the squids and cuttlefishes. Most species of octopus lack a shell, and their most obvious feature is the ring of eight arms or tentacles with suckers which surrounds the mouth. Like squids and cuttlefishes, octopuses possess a funnel, or siphon, with which they can rapidly jet propel themselves about if necessary, although they can also crawl about using their tentacles.

Inside the 'head' Internally, the bulbous 'head' contains the gills, a highly evolved nervous system, and reproductive, circulatory and digestive systems. The common octopus has been studied in great detail, and much that has been learned about it applies equally to other species.

The brain is large and complex, making it capable of learning, and allowing it to perform a range of activities beyond the scope of other invertebrates. In addition, there are concentrations of nerve cells in other parts of the body, and a number of functions, such as digestion rate and circulation of the blood, come largely under direct nervous control – in vertebrates these roles are performed by hormones.

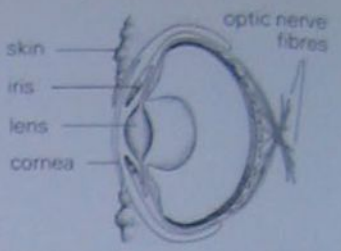
The blood flows through vessels, as it does in vertebrates, but the oxygen-carrying green pigment – haemocyanin – does not occur in blood cells (as does the red pigment haemoglobin in vertebrates), being carried instead as part of the blood fluid. The blood is very viscous and difficult to pump around the body and, in order to maintain blood pressure, all the main blood vessels can contract to assist the flow. Despite this assistance an octopus cannot manage with one heart, and there are two secondary hearts, one for pumping blood through the fine network of vessels in each of the two gills.

Night strike Octopuses are solitary animals which spend most of the daylight hours hidden in a cavity, although they are ever-watchful of events in their vicinity. They wander mostly at night, their arms carefully exploring for food such as other molluscs and crustaceans.

Vision is important, and an octopus is read-

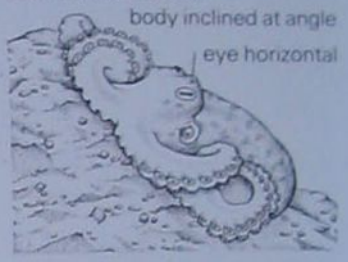
Above: The octopus can change not only its colour but also its skin texture to match its background, particularly when threatened or when lying in wait for prey.

Octopus eye-view



Above: Octopus eyes resemble those of vertebrates.

Below: The eyes always remain horizontal.



ily enticed from its lair by any interesting movement. If a crab should pass by, the octopus becomes visibly alert, its eyes rising and falling on its head as its gaze fixes on the potential meal. It glides towards the crab on its arms, and waves of changing patterns and colours pass across its body as it seems scarcely able to contain its excitement. When within striking distance it shoots forward, propelled by a burst of water through the funnel, and engulfs the crab beneath the web of skin that extends down between its arms. The crab is quickly immobilised by a nerve poison secreted by the salivary glands, and the octopus returns to its home where the crab is consumed at leisure. Digestive juices are thought to penetrate the crab before ingestion, facilitating complete removal of all the flesh before the shell is discarded. When the octopus eats a hard-shelled mollusc, it penetrates the shell by slowly drilling with its radula (a tongue covered in many small teeth) until the shell is punctured.

Mating in octopuses An octopus does not usually tolerate the presence of another octopus, the larger eating the smaller or both fighting until one flees. To avoid such a confrontation, potential mates have means of recognising each other and appeasing agressive tendencies long enough for copulation to take place.

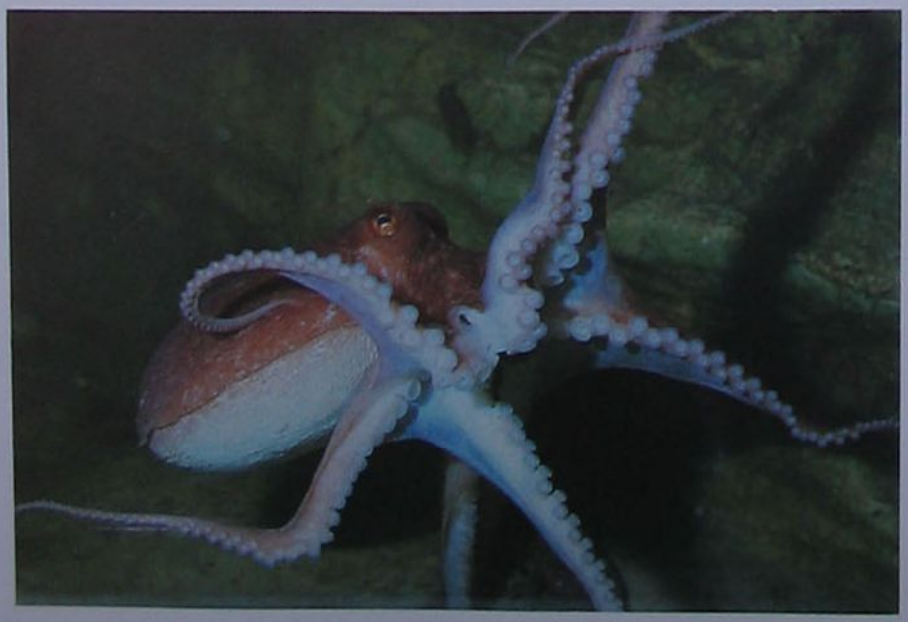
A male carries particularly large suckers on his arms, which he may display as a prelude to mating, and which seem to serve as a means for the female to recognise his sex. Once this has been established, the male inserts spermatophores into the body cavity of the female using his hectocotylus, an arm modified with a channel.

Female sacrifice To prepare for egg-laying, the female retires to a cave or other safe crevice, the roof of which she carefully cleans with repeated sweeps of her arms, other debris being removed using her suckers.

For a week or more the common octopus lays thousands of eggs which, after passing through her funnel, are manipulated by the small suckers near her mouth and attached to the cave roof, embedded in a gelatinous mass. The female guards and cares for the eggs for the rest of her life, and she may never feed again. The eggs take from one to one and a half months to hatch, and throughout this period the female octopus maintains vigilance, delicately scanning the eggs with the tips of her arms and playing jets of water across their surface. Any intruding animal is pushed away with no attempt to capture it as food. Soon after her eggs hatch the female dies.

The young The eggs of the common octopus are very small, and the tiny, newly hatched animals float as part of the plankton before settling into an adult lifestyle. Patches of minute bristles usually cover the body of a

Below: The lesser octopus can be quickly distinguished from the common octopus by the single row of suckers on each tentacle, a fin ridge which extends around the body, its smooth skin and its musky odour.



larval octopus when it hatches; these may have assisted escape from the egg-casing but will now help the octopus to float. Eventually the bristles develop into numerous warts that cover the adult body. In the warmer parts of its range the juvenile octopus remains planktonic for a few weeks, but at the northern limits of its distribution in the English Channel this may last for three months.

From a size of about 3mm when newly hatched, common octopuses reach a length of 10mm ($\frac{1}{2}$in) by the time they settle on the sea-bed. Growth is very rapid; by the time they are mature after some eighteen months to two years, females may weigh over 1kg (2.2lbs). The males mature much earlier than females, when their weight is under 120gm (just over 4oz), but they seem to live longer and there are recorded weights of up to 25kg (55lb).

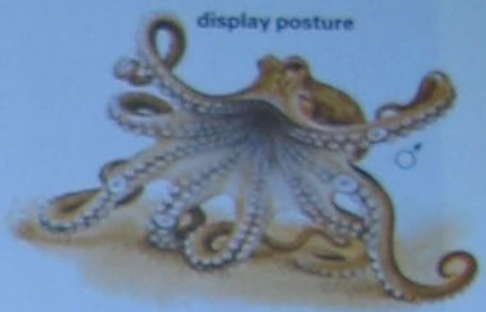
In most years the common octopus is fairly scarce in England even along the southern coast, and it is hardly ever found further north. Some planktonic juveniles are occasionally carried to more northern areas, but they are unlikely to survive. There have been occasions in the past, however, when numbers of the common octopus have reached plague proportions on the south coast. These plagues normally follow one or more years of warm weather.

The lesser octopus The second British species, the lesser octopus, is much more widely distributed around our coast, but it lives in deeper water than the common octopus and little is known about its life history. It starts life larger than the larval common octopus but never attains such a large adult size.

A number of features distinguish the two species. The lesser octopus has a single row of suckers down each arm, as opposed to two rows in the common octopus; a fin ridge extends around the body; the skin is smooth; and it has a distinctive musky odour. Far fewer eggs are laid, and these are not guarded by the female. Any predator large enough to catch an octopus in open water makes short work of it.

Mating behaviour

The male displays the large suckers on his second and third tentacles as a prelude to mating. Copulation consists of the male depositing sperm packets into the female's mantle cavity near the opening of the oviduct, using a specially grooved tentacle.



Above: It is rare to see a lesser octopus washed up on the beach. This specimen has probably been discarded from a trawl catch.

Below: A lesser octopus probing about on the sea bottom for food.

Survival Octopuses are preyed on by a wide range of animals – they present an attractive meal in the form of a highly nutritious package of protein minus bones.

Young octopuses are particularly vulnerable, especially when still planktonic. A number of fishes specialise in probing crevices in search of food, and no doubt include a large number of octopuses in their diet. To protect itself, an octopus is able to squeeze into the tiniest gap or shoot rapidly away from danger by jet propulsion, and it can also exhibit a most effective camouflage, with changes in colour and surface sculpture to match its background.

The octopus's most familiar response to attack, however, is to discharge a quantity of cloudy ink, which acts as a visual decoy. The way in which octopus ink acts as a chemical attractant has been well illustrated using moray eels kept in aquaria. If just a tiny drop of octopus ink is added to the aquarium, the eels at once become alert and search excitedly for an octopus meal. In natural situations the eel would frenziedly follow the dispersing ink while the octopus made good its escape.

Left: The white-tailed eagle is a huge brown bird with a massive yellow bill and yellow feet. Adults have short, somewhat wedge-shaped white tails and noticeably pale heads. Juvenile and immature birds are darker, with brown tails, the latter showing progressively more white until complete adult plumage is attained at about seven or eight years of age. By 1982 some of the eagles released on Rhum were approaching this age, as is the one shown here.

THE WHITE TAILED EAGLE

The white-tailed eagle, once common in Scotland, had been exterminated there by 1916. Now a bold attempt is being made to reintroduce it.

The 'sea eagles' of the genus *Haliaeetus*, all large birds of prey, are more closely related to kites and Old World vultures than to other eagles. Most of them are adept fishers, taking prey from the surface in their talons and sometimes even wading after it. They are also efficient hunters of birds and small mammals. Scavenging, carrion feeding and piracy–stealing the prey of other predatory birds, gulls and even otters–are important aspects of their way of life.

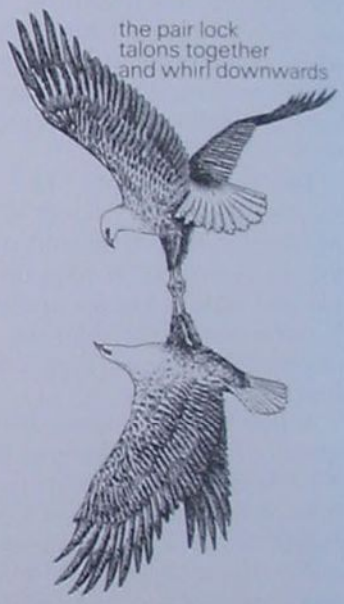
Britain's other eagle One of these sea eagles –the white-tailed eagle–occurs in Britain today. It is a rare but thrilling sight in the Hebrides and on the north-west Scottish mainland and, though it is comparable in a broad sense to the golden eagle, the two species are not difficult to tell apart. Of the two, the white-tailed eagle is slightly bulkier, although a big female golden eagle may be larger than a male white-tailed eagle. There is a pronounced size difference between the sexes in both species, and female white-tailed eagles may be 15-25% larger and heavier than males.

In shape and movement, the two species are rather different from one another. The white-tailed eagle has a more vulturine outline, with long, broad wings, much shorter tail and much more prominent head and bill. The golden eagle has more balanced proportions with its longer tail and slimmer wings, and its flight is more elegant. It soars with its wings slightly raised and pressed forward, while the generally more ponderous-looking white-tailed eagle soars on flat wings held straight out from the body.

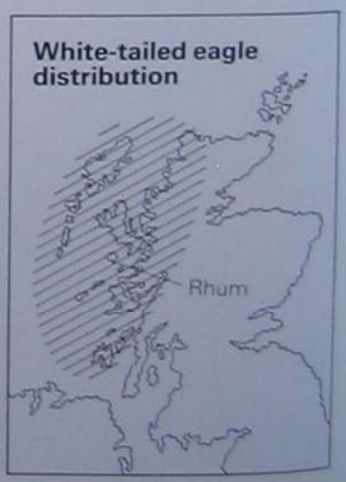
Giant nests Pairs of white-tailed eagles form breeding territories, with a home range averaging 50-65sq km (20-25sq miles) in most cases. Water is an essential element for these birds–river valleys, large lakes (or chains of smaller ones), extensive marshes and rocky sea-coasts being their preferred habitats on the Continent. Nests may be on crags (especially those of coastal birds) or in tall trees inland. The biggest may be up to 2m (6ft) in diameter and some tree nests may be as much as 3m (10ft) deep. One four-year-old nest

Cartwheels in the sky

Below: A pair of birds soar together, calling. The male dives towards the female; she rolls over and they touch talons. Sometimes they grapple talons and even 'cartwheel' downwards.



Below: The area in which white-tailed eagles have been reported and may occasionally be seen.



examined in detail weighed over 230kg (500lb) and contained no fewer than 2900 branches over 2m (6ft) in length!

Persecuted species The birds' prey includes small mammals, up to the size of hares and rabbits, but there is little evidence of lamb killing or indeed of much damage to any livestock. It would not be impossible for a white-tailed eagle to kill a lamb, but so far all lambs that the birds have been observed to eat were taken as carrion. The persecution that the birds have suffered on the basis of preventing damage to livestock is therefore unjustified.

Even so, deliberate and relentless human persecution has been at the root of the white-tailed eagle's great decline–and local extinction–over most of its former wide European range. Two hundred years ago, the white-tailed eagle must have been a familiar sight around the western coasts and islands of Scotland where, judging by all the contemporary accounts, it was quite common. By the middle of the 19th century, however, it was in rapid decline in the face of persecution; and the final pair last bred on Skye in 1916.

A fresh start In recent decades man's persecution of eagles–though still continuing–is somewhat less intense, and so the conditions were judged suitable for a reintroduction. The first real attempt was made in 1968 when the RSPB brought four eaglets from Norway, reared them and released them on Fair Isle, halfway between Shetland and Orkney and a former breeding area. For various reasons the experiment failed, but it has been repeated since then on a large scale and over a longer time-span by the Nature Conservancy Council, based on the Rhum National Nature Reserve in the Inner Hebrides. The RSPB is also helping by monitoring eagles that leave Rhum and standing by to mount protection schemes for them.

Between 1975 and 1981, 45 young birds were brought in from Norway under licence; three died in captivity but the remaining 42 were reared and released. Ten more birds were brought in during 1982. Of five birds found dead so far, two have died of unknown causes, one was killed through striking an overhead power cable, one was poisoned through eating an illegally laid poison bait and the other was suspected of having been poisoned. By spring 1981, birds had been reported from many areas in western Scotland and at least 25 to 28 survivors had been identified, with the oldest in near-adult plumage and the first indications of pair formation. The experiment was clearly succeeding, and in the 1982 season the omens were even better–but by the end of the season, although nests were found, no eggs had been laid. It remains to be seen what will happen next, but all the signs are there for successful recolonization in years to come.

The eagle's financial ally

The Eagle Star Insurance Group has publicised endangered eagles on a world scale through its well-known posters. The first one of these to appear featured the white-tailed eagle, using the magnificent painting which is reproduced here (right). Since then posters have shown nine other species of eagle from all over the world, but the insurance group has made itself a special ally of the white-tailed eagle. It provides the funds for all RSPB activities in the reintroduction programme–including monitoring and protecting the nests of these birds.

White-tailed eagle (*Haliaeetus albicilla*). One of the world's eight sea eagles; large predator breeding in Europe and northern Asia east to the Bering Sea. Last bred in Scotland in 1916. Length: females 84-91cm (33-36in); males 70-77cm (27-30in).

Below: Swimming birds such as ducks and auks form a distinct and important category of prey. Often two white-tailed eagles hunt together for this type of quarry. The hunting pair take turns to harry the victim, plunging at it from a height. The attacks are too fast for it to escape by flying, and its only option is to dive underwater for safety until, finally exhausted, it becomes an easy victim for the eagles.

Hunting in pairs

FLOATING CARPETS OF DUCKWEED

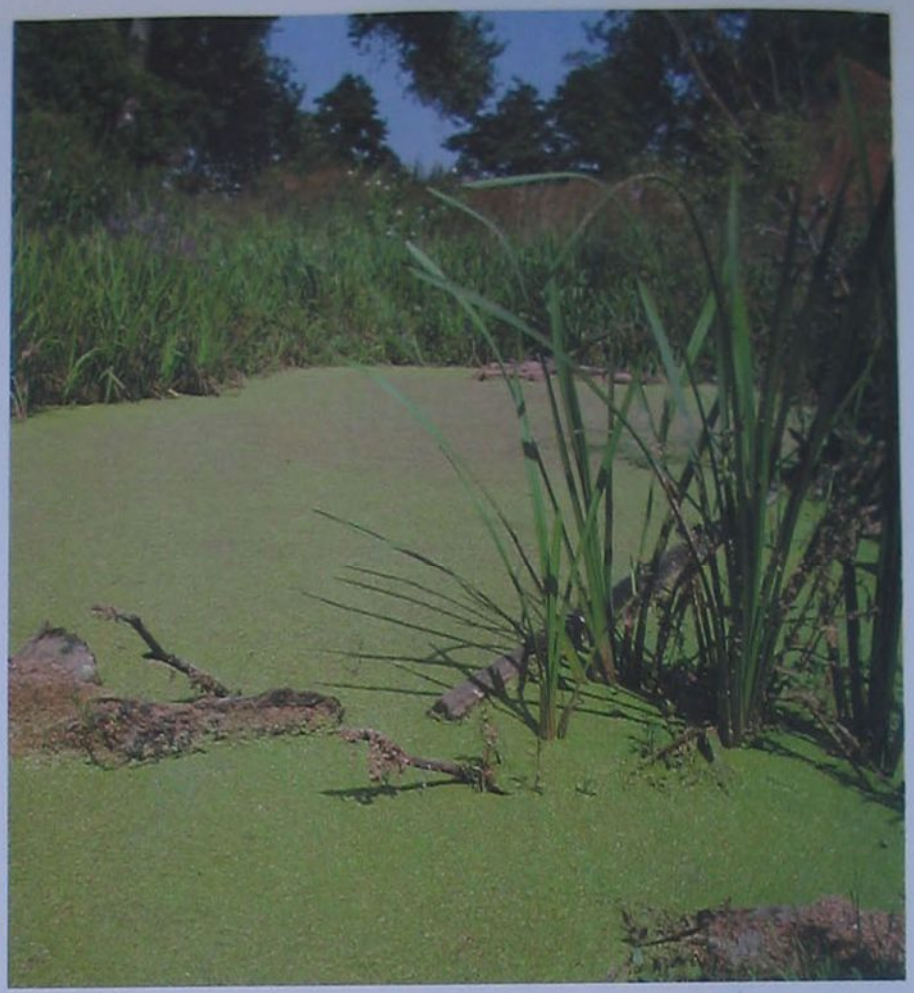
Duckweeds – a group of tiny floating plants which can cover still waters in a carpet of green – include Britain's smallest flowering plant.

The still waters found in many parts of lowland Britain are rich in dissolved salts, rich enough indeed for aquatic plants to grow in these waters and absorb enough salts for their needs.

Some aquatics are anchored to the bed of the water via their roots, but others are free-floating and have the advantage that they can grow in areas where the water is too deep for bottom-rooted plants, thus avoiding the competition for space that so often occurs in shallower waters. Also, by floating on the surface of the water they are not competing for light with submerged water-weeds or the numerous types of algae that abound in rich waters.

Tiny duckweeds The smallest aquatic flowering plants in Britain are the duckweeds. They can flourish where the water is much too shallow for other aquatics, for example in shallow drainage ditches at the edges of fields or in water-filled wheel ruts. They can even be found in a tiny pool formed in the muddy depression of a cow's hoof-print.

Duckweed is often seen forming an unbroken carpet of green over a stretch of still water, usually one with a muddy bottom rich in decomposing organic matter. The danger of duckweed hiding water of some uncertain depth probably accounts for some of its less savoury local names, given to it to frighten children away. For example in the west of England duckweed is known as Jenny Greenteeth, who was also a pond-elf supposed to lurk hidden from view in duckweed-covered waters.



Above: The covering of duckweed over this stretch of water is so complete that it looks at first glance like a lawn.

Below: Gibbous duckweed, here with the small green or reddish domed thalli, is fairly widespread in Britain, though absent from the far north and parts of the south-west. The rosettes of larger, darker green leaves belong to a quite different species of aquatic, water starwort, a bottom-rooting plant.

Duckweed structure If you examine a carpet of duckweed you will find that it consists of innumerable small leaf-like structures called 'platelets'. Each platelet has some of the properties of both a leaf and a stem, and so is given a distinct name: 'thallus' (plural thalli). Each thallus usually has one or more roots hanging from its under-surface.

The flowers are not often recorded in Britain, partly because they are inconspicuous. Indeed, some species of duckweed have never been recorded in flower in this country. When flowers do form, they usually appear on plants that are fully exposed to the sun. The flowers are extremely tiny, sometimes less than 1mm across, and consist of a single female flower, with just one ovary, and two male flowers, each with one or two stamens. Both male and female parts are enclosed in a hood-like sheath borne in a shallow pocket on the edge of the thallus.

Great duckweed The largest British duckweed is the great duckweed, a plant that is fairly widespread in this country, though not particularly common, and is absent from the far north and parts of the south-west.

Each thallus of the great duckweed is up to 15mm (⅗in) long, green on top and often reddish-purple beneath. In the autumn, the plants produce specialised purplish thalli

called turions, which become detached and sink to the bottom of the water. Here, they stand a much better chance of surviving the rigours of winter than does a floating plant because they are less likely to be frozen into the ice. In the spring, the turions become buoyant and rise to the surface, where they resume growth and start producing normal green thalli.

Commonest and smallest By far the commonest of the British duckweeds is the common duckweed, which can be found on almost any body of still water in Britain, often covering the surface of the water almost to the total exclusion of other aquatics. The thalli are up to 4mm across and more or less flat with a single root. Among British duckweeds this is the species most likely to flower, bearing its small greenish blooms in June and July.

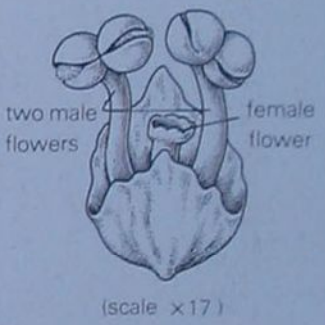
Another species, rootless duckweed, has the distinction of being Britain's smallest flowering plant. Each minute thallus, scarcely 1mm across, is a blob of tissue barely recognisable as a flowering plant and looking more like an alga. Unfortunately, rootless duckweed is close to the limits of its range in Britain and does not flower here. It spreads by a new thallus budding from one end of an old thallus. This species occurs only in southern England and Wales, and even here it is becoming rarer as more and more of our wetlands are being drained.

Submerged duckweed Ivy duckweed is an oddity among British duckweeds because it is normally completely submerged. It differs in many other ways, too. The thalli are more elongated than other species of duckweed, and taper at the base into a short stalk. At the base of the stalk two more thalli arise opposite each other and at right-angles to the original thallus. In this manner, a three-dimensional pattern is built up of several interconnecting thalli.

The plants are also a much darker green than other duckweeds and their thalli are translucent, but when ivy duckweed is ready to flower its similarity to the other duckweeds becomes apparent. It sends up fertile thalli to float on the surface of the water. These thalli are smaller, oval and a paler green than the submerged thalli, and altogether much more like the typical duckweed thalli.

Duckweed look-alike A plant very similar to the duckweeds, though it is a fern rather than a flowering plant, is *Azolla filiculoides*. This, an introduced species from North America, is becoming increasingly common in southern Britain. It floats on the surface of still waters, forming carpets of foliage in a similar manner to duckweeds. During a long hot summer it grows at a prodigious rate and, in a small pond, serious overcrowding can push plants at either the middle or the edge right out of the water.

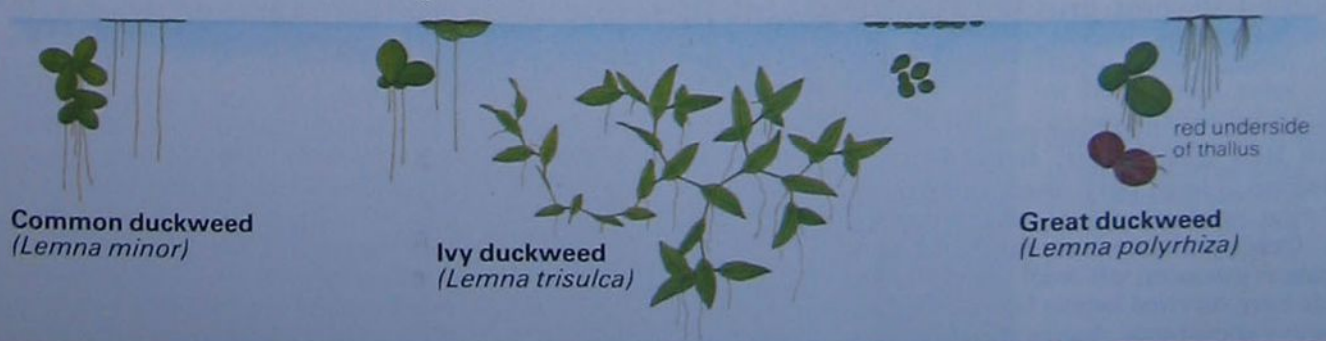
Above: As well as being an aquatic, *Azolla* can also survive for some time on sites that are merely damp, for example among mud or wet moss.
Though superficially similar to duckweeds, *Azolla* has a quite different structure, its branched stems bearing two ranks of leaves.



Above: Male and female flowers of common duckweed, the species most likely to flower in Britain.

Opposite: The common and the great duckweeds, the latter having the larger thalli, about 15mm across.

British duckweeds



GOATS–BECOMING POPULAR AGAIN

The recent upsurge of interest in self-sufficiency has increased the popularity of goats, and they can now be found in backyards or tethered on road verges as well as in dairy herds. Some are also kept for their good looks, others for their wool.

Goats are kept for four main purposes. In the British Isles their primary function is the production of milk, but in many other countries meat production is of greater importance. One breed has been developed as a specialist producer of wool, while other breeds have survived largely because of their attractive appearance, despite their relatively poor milk or wool yield.

Above: A Golden Guernsey nanny goat and her kid, one of our two surviving native breeds (the other is the English). Both are minority breeds that have been recently revived.

Valued milk Goats' milk is highly valued as it differs from cows' milk in several important ways and is useful in treating certain diseases. The fat particles in goats' milk are smaller than those in cows' milk and are more evenly distributed. Thus the cream rises more slowly and the milk can be frozen for longer periods without separating out. The curd is softer, and the milk also contains a much higher level of salt.

These factors, combined with what is known as the greater natural buffering quality (the well-balanced components) of goats' milk, make it more easily digested, and valuable in the feeding of infants or those who suffer from disorders of the digestive tract, such as ulcers. It is also a useful substitute for cows' milk in people suffering from allergic conditions which are caused by a reaction to the bovine protein in cows' milk, because goats' milk does not cause this reaction.

Milk absorbs odours easily and should not be stored near anything which smells strongly. This accounts for the reputation which goats'

milk has acquired – sometimes the male goats, with their characteristic strong odour, have not been separated from the females which are being milked.

Apart from being drunk fresh, goats' milk is processed into many other products including butter, yoghurt and cheese.

Imported goats Most breeds of goat in Britain are used for milk production. Goats of dairy type were imported in large numbers in the late 19th century, mainly from Switzerland but also from North Africa and the Middle East. Some of these goats have been kept as pure breeds, such as the Saanen and Toggenburg, but in most cases the imported goats were mated with native animals to produce new breeds such as the British Saanen, British Toggenburg, British Alpine and Anglo-Nubian. In addition, two native breeds of goats have survived – the Golden Guernsey and the English.

The Saanen The most popular specialist milking breed of goat is the Saanen. It originated in the Saane and Simme valleys in Switzerland but it has been exported all over the world. It is pure white in colour and should never have any black or other colour hair. The Saanen is a very docile breed, this quality resulting from the Swiss practice of stall-feeding throughout the winter.

The Saanen is a medium-sized goat with a leggy, lean conformation typical of dairy goats. The face is long with a concave profile, and the ears are carried alert and pricked forward. It may have a beard or tassels, but neither is essential. In Switzerland the Saanen is described as hornless, but in practice some goats are horned, and as the continued selection among goats for hornlessness results in an increase in the incidence of hermaphrodism, the normal practice is to use horned

Above: Anglo-Nubian twin kids with their mother, and (right) an Anglo-Nubian in an aggressive mood. This breed is derived from crossing native animals with goats from North Africa and the Middle East. The first of these exotic goats to arrive in Europe were presented in 1860 to Napoleon III by the King of Abyssinia; they supplied rich milk for a young hippopotamus during the journey.
Goats must be controlled as they are natural browsers rather than grazers, and given the opportunity they destroy trees and shrubs, a characteristic which has led them to be blamed for causing erosion and desert encroachment in some parts of the world.

Left: The Bagot, perhaps the rarest and most endangered breed of goat in Britain today. According to tradition the goats were originally presented to Sir John Bagot by Richard II, having been brought to this country by the Crusaders returning from the Holy Land. A goat's head appeared on the crest of the Bagot family in the late 14th century. Since then the herd has run as a semi-feral unit in the woodland around Blithfield Hall, the Bagot family's country seat in Staffordshire. Small groups of animals have been removed from time to time to establish other units. They are very beautiful animals and they have proved very popular in country parks and amenity centres.

Above: A British Saanen kid beside two British Toggenburg kids. Twins occur fairly often, and triplets are not uncommon. Gestation takes 5 months.

Above: **Golden Guernsey** Native dairy breed, smaller than the dairy goats of Swiss origin. This breed has a low milk yield compared with the modern specialist dairy breeds.

goats for breeding, and to remove the horn buds from the young kids under anaesthetic.

The British Saanen This breed was developed in Britain by mating imported Saanen goats with native stock, and it was established as a breed in the early 1920s. It is very similar to the Saanen in type and temperament, but is larger and stronger and achieves higher yields of milk. Yields of more than 2000kg (4400lbs) of milk in one year have been surpassed by some outstanding animals. This breed is the most popular milking goat in Britain today.

The Toggenburg The first Swiss breed to be exported to Britain was the Toggenburg, seven animals arriving from Paris in 1884. It originated in the districts of Obertoggenburg and Werdenberg but, like the Saanen, it has been exported to many other countries.

The Toggenburg has a distinctive colour pattern. The base colour varies considerably from light fawn to mid-brown, but the white markings are typical. The muzzle is white, and a white stripe runs up each side of the face, in front of the eyes and around the edges of the ears. The inner surfaces of the legs are white, as are the outer surfaces below the knees and hocks. There is often a white area around the tail region and sometimes also around the tassels on the neck.

This breed is a smaller animal than the Saanen, and the milk yield is also lower, which is the main reason for its relative unpopularity. Both sexes grow long hair, sometimes seen as a fringe down the back and hind-quarters, but in some cases covering the entire body except for the head, neck and legs.

The British Toggenburg This breed originated from a mixture of imported Swiss Toggenburg animals and native British goats, and was recognised as a breed in 1925. It is larger than the pure Toggenburg and has stronger bones and a more robust conformation. The head and ears are larger and the facial profile is straight. The hair is always short, and the base colour may be darker, sometimes as deep as chocolate brown. The milk yield is also higher than that of the Toggenburg.

The British Alpine Although this breed derived in large part from imported animals, it cannot trace its ancestry directly to any foreign breed. It evolved from general cross-breeding in the early part of this century but Swiss blood predominated and a famous female, Sedgemere Faith, imported in 1903, was a dominant influence in the early years of its development. Sedgemere Faith was black in colour with the same white markings found in the Toggenburg, a colour pattern which is now established in the British Alpine breed.

The visual appeal of the British Alpine arises partly from its glossy black coat and contrasting white markings. Otherwise the breed is very similar to the British Toggenburg, although it is usually a little larger with longer legs and has a greater capacity for browsing and bulky foods.

The Anglo-Nubian This goat is a complete contrast. It is a long-legged animal, with an upright stance and head held high. The convex curve of the nose and the long, pendulous ears are very distinctive. The colour is most commonly red or tan, but it varies widely through mottled or dappled greys and tans.

English A hardy, native dairy breed that has only recently been revived in the British Isles.

British Alpine Evolved from general cross-breeding early this century. Similar to the British Toggenburg.

Anglo-Nubian Provides very rich milk. Note long, drooping ears, upright stance. Adult female 55kg (121lbs).

and black hairs may be intermingled with red, white or cream. Any colour is permissible. The coat is short, glossy and free from any long fringes of hair.

The Golden Guernsey and the **English** Both are minority breeds, having been revived only recently. The Golden Guernsey is a relatively small animal, more robust than the specialist dairy breeds, but achieving a lower yield of milk. The colour varies, but is usually an attractive honey-gold with no white markings. The English breed is based on native goats and is much hardier than the other dairy breeds. It is most commonly grey or brown in colour with a distinctive black line (eel-stripe) running down the back from the base of the horns to the tail. There are also dark stripes on the front of the legs. The hair is often long with a woolly undercoat. Horns are present in both sexes and sweep backwards and outwards.

Meat and wool In Britain there are no breeds kept specifically for meat, although the consumption of goat meat is increasing, largely as a result of the immigrant population. In some parts of the world, such as China and India, goat meat is an important part of the diet. In Britain the source is mainly young males which are surplus to the breeding requirements. The joints are very lean, which is suitable for current demand.

Within the last few years the interest in wool-producing goats has been revived in Britain. Only one breed, the Angora, is bred for this purpose, and it has been imported from New Zealand and Australia. Angora goats evolved in Asia Minor and take their name from a province in Turkey, but they have been exported widely to North America, South Africa and Australasia. They are pure white in colour, with wool that hangs in long, lustrous ringlets. The whole conformation is small and slender, with a delicate face and long pendulous ears.

The wool, known as mohair, is distinctive for its lustre, resilience and warmth in relation to weight. It is used in textile manufacture in many ways, from high fashion knitwear to carpets. It is blended with other wools to give increased lustre, strength, ability to absorb dyes, and less tendency to 'ball up' on the surface. The quality of the wool is assessed by measuring the diameter of the fibres. Kid mohair is the softest and the finest with a fibre diameter of 20-30 microns (one micron equals one millionth part of a metre); adult mohair is coarser.

The Bagot Perhaps the rarest and most endangered breed of goat in Britain is the Bagot. This breed has never been selected for commercial qualities and is of little value for milk, meat or wool production. It is a small to medium-sized goat with long hair and large curved horns which sweep backwards. The head, neck and forequarters are mainly black, although there is usually a white blaze down the face. The hindquarters are mainly white. A similar colour pattern is found on the Schwarzhal goat in Switzerland, and this breed is probably the ancestor of the Bagot.

Goats can be kept in a wide variety of conditions, although the specialist dairy breeds based on imported animals are delicate and need to be housed and protected from bad weather.

Above: A Toggenburg goat. Most billy goats have beards and smell strongly. They are known for their bad tempers and may be aggressive towards people.

Above: **British Toggenburg** This breed is larger than the pure Swiss Toggenburg. Mature females weigh up to 63kg (140lbs) and they give more milk than the Swiss Toggenburg.

British Saanen The most popular milking goat in Britain; 6-8 pints of milk a day is quite common.

Angora This breed may produce up to 2kg (4½lbs) of wool when it is sheared twice a year. 55kg (121lbs).

Bagot A breed of little value for milk, meat or wool but kept for its beauty in parks and amenity centres.

THE GREAT SILVERY WATER BEETLE

One of Britain's largest and bulkiest beetles, the great silvery water beetle belongs to the family Hydrophilidae–a family renowned for their vegetarian nature and the fact that, despite their aquatic existence, they are neither fast nor efficient swimmers.

The largest insect found in ponds and weedy ditches is the great silvery water beetle (*Hydrophilus piceus*), the bulkiest British beetle apart from the male stag beetle. It was comparatively common at one time but sadly it now only occurs locally in England south of Yorkshire. Here it is found in ponds and dykes, feeding mainly on aquatic plants, although water snails occasionally add a little variation to its otherwise vegetarian diet.

Silver swimmer If you examine one of these beetles carefully you can see that its antennae are short, clubbed and held back under the eyes. The other organs you could easily mistake for antennae are in fact the palpi, which have taken over the sensory duties of the antennae.

The beetle's underparts are covered with short yellowish-brown hairs which are water-repellent. These hairs trap a thin film of air giving the beetle a silvery appearance underneath when it is below the water. The beetle is actually a blackish-olive colour.

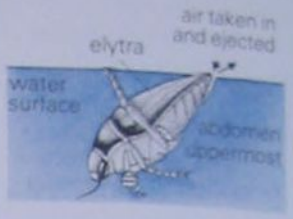
The male's front tarsi are enlarged in a triangular shape to form claspers although they lack the suckers which are found on the great diving water beetle. The middle and front legs on both sexes are fringed with hairs and used for swimming. The beetles fly from pond to pond at night and they are equipped with well-developed wings which are folded beneath the elytra.

Water crawler When you watch the great silvery water beetle in a pond the differences between it and the great diving water beetle soon become apparent. Unlike the latter, it is a poor swimmer, moving its legs alternately–as if walking. It lacks the strong rowing movements of most other aquatic insects and gives the impression of crawling rather than swimming through the water.

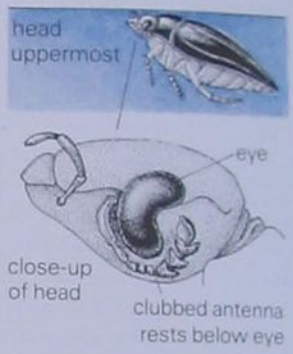
Its respiratory system is also quite different from that of the great diving water beetle. When it needs to replenish its air supply, it rises to the water surface, positioning itself not tail upwards but nearly horizontal and inclined to one side, with its head uppermost. The inclination of the body automatically brings one of the antennae to the water surface. As the antenna's club is covered with

Breathing systems

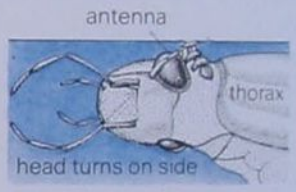
Below: *Dytiscus marginalis* replenishes its air supply at the surface by raising its elytra so the spiracles can take in air directly.



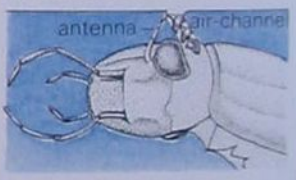
a) beetle rises to surface



b) antenna brought forward

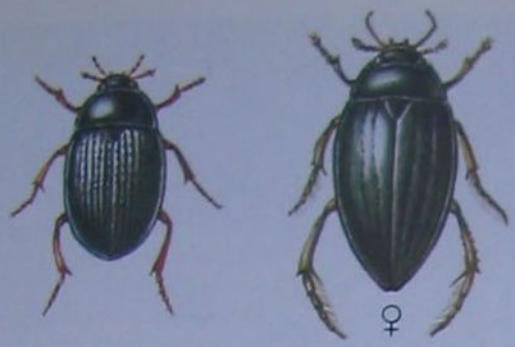


c) antenna breaks surface



Above: *Hydrophilus piceus* positions itself almost horizontally below the water surface (a). In this way only the antennae break the surface, their hairy tips forming a 'funnel' down which the air passes to air retaining tracts, finally reaching the spiracles (b,c).

Above left: The great silvery water beetle's name comes from its appearance under water–its underneath glistens from a thin film of air trapped between the ventral hairs. It is a poor swimmer (top right), preferring to creep among the pond vegetation.



Hydrobius fuscipes. Length 6-7mm (¼in). Black with metallic reflections.

Great silvery water beetle (*Hydrophilus piceus*). Length 4cm (1⅝in). Black/olive.

water-repellent hairs a funnel-shaped channel is formed which links the beetle's air-retaining tracts to the atmospheric air. Situated within these air-retaining tracts are the spiracles (air-vents) through which air enters the body. Fresh air is taken in and stale air ejected by rhythmical pumping movements of the abdomen. Sometimes the beetles breath in too much air and become over-buoyant, making it necessary to dislodge some before they are able to move freely.

Floating cocoon Mating between great silvery water beetles takes place in spring, and afterwards the females can be seen searching for floating leaves. A most unusual process, for beetles, then occurs. On finding some suitable pond weed, the female lies under the leaf, holding on with her legs, and proceeds to push in and out two small tubes at the end of her abdomen. These together make a spinneret–a spinning organ–enabling her to spin a silken cocoon around the end of her body.

When the cocoon is half completed the female neatly lays her eggs, wrapping each one in silken thread and placing them side by side in the upper half of the cocoon. She then builds the second half of the cocoon, withdraws her abdomen, and finishes it off with a 'mast' which projects upwards. Finally she fills the cocoon, which is about 2.4cm (1in) long, with air from her own store. The cocoon is waterproof and floats, remaining attached to a leaf or similar object. One adult female may complete two to three cocoons in her lifetime.

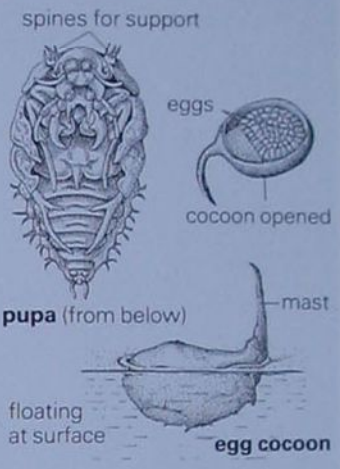
Sluggish larva The eggs hatch after a month and the tiny larvae swallow the air in the cocoons, making themselves buoyant. After about twelve hours they make a hole in the top of the cocoon and escape into the water. They are not unlike the larvae of the great diving water beetle, although they are fatter and more sluggish.

A pair of powerful jaws betrays the larva's carnivorous nature, although it is not as fierce as the great diving water beetle's larva. It feeds mainly on water snails. The larva seizes the snail with its mandibles and then rises to the surface where it pushes its tail up into the air, clasping a leaf or a twig for support. It then bends backwards and rests the snail upon its back, puncturing the unfortunate victim to allow its juices to escape. These are then sucked in by the larva.

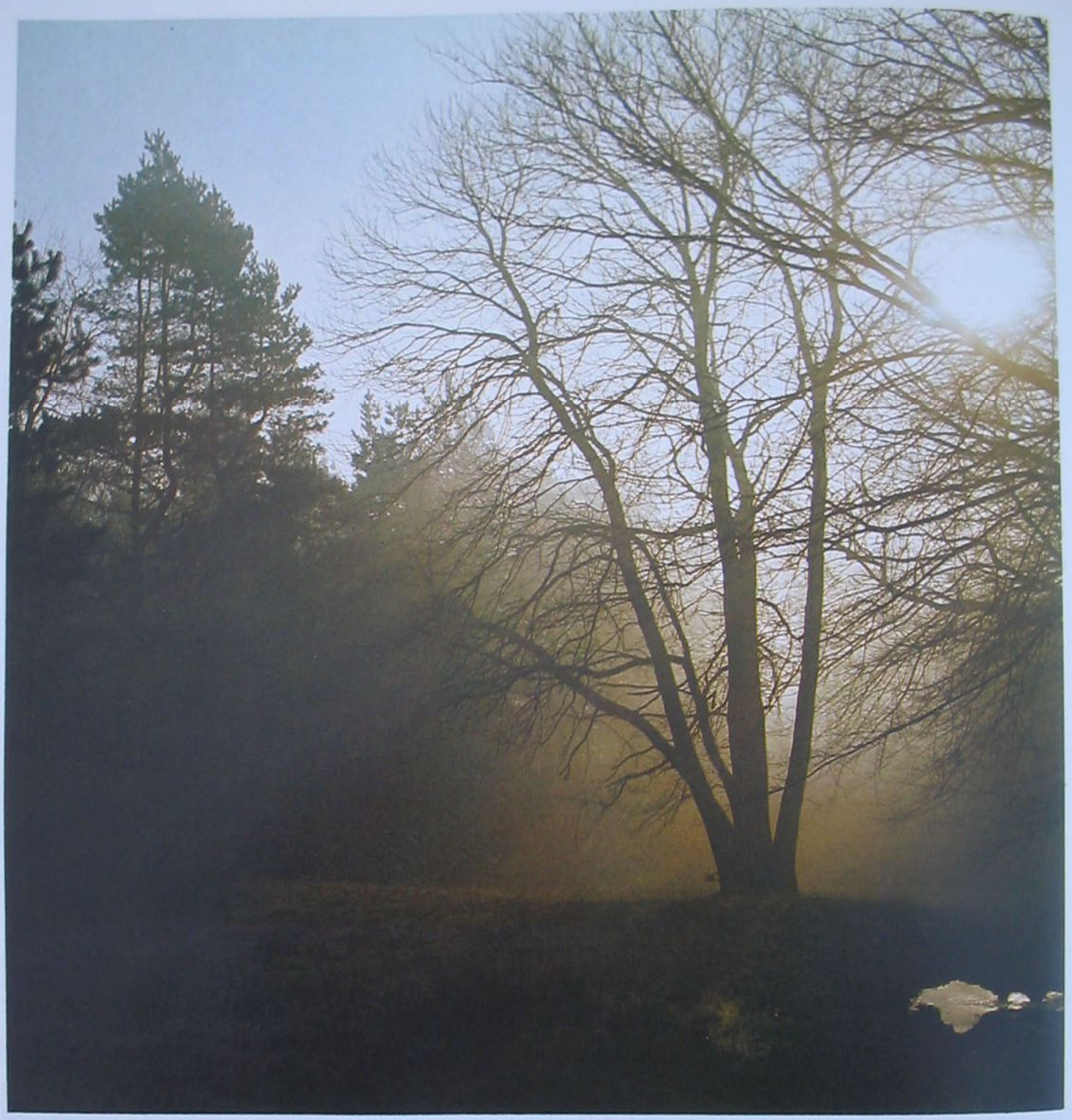
When fully grown, in July or August, the larva leaves the water and makes a pupal cell in the damp soil by the edge of the pond. The pupa has two prominent hooked spines on its head and one on its tail which support it on a tripod, away from the damp soil.

The adult beetle emerges from the pupa after a few weeks, but spends the winter hibernating in the cell. Only in the spring does it finally come out of the ground.

Common hydrobe There are about 90 other British species belonging to the family Hydrophilidae, but many are terrestrial. One common aquatic species is the common hydrobe (*Hydrobius fuscipes*), frequently found in shallow grassy ponds where it looks like a smaller version of *Hydrophilus piceus* with its silvery underneath. They are easy to tell apart, however as *H. fuscipes* is about a sixth of the length of *H. piceus*.



Above: The great silvery water beetle lays its eggs in a floating cocoon; the larva (below) is carnivorous. After a short pupal stage the adult emerges, but overwinters within its pupal cell.



FLOATING ON AIR: AERIAL WILDLIFE

The biosphere, the part of the world that supports life, contains three major elements–water, earth and air. The air, forming an envelope round the earth and water, is the least populated of the three, but does have a distinct, if floating, population.

The air not only provides living space for a number of animals–it also plays a vital role in the lives of all earth-bound organisms. Its most obvious function is that of a gigantic reservoir of oxygen and carbon dioxide. Variations in atmospheric pressure, temperature and moisture content, together with the continuous movement of the air, all contribute to our weather and thereby have a profound effect on all wildlife.

Winds stem from the pressure differences at various parts of the earth's surface, with the air moving from high to low pressure areas. The strongest winds come when the pressure falls markedly before storms. Many otherwise immobile objects are carried by the

winds, which sometimes pick up surprisingly large objects and carry them for considerable distances before dropping them. There are even reports of showers of frogs after strong winds, but most of the objects carried are much smaller.

Dust is the most abundant of the inanimate materials picked up by the wind, often being carried for vast distances and for very long periods. Red dust from the Sahara, for example, is occasionally dropped over parts of southern England. Urban and industrial development add enormous amounts of dust and smoke to the air, and this can have several marked effects on plant and animal life. Among the well-known phenomena linked to such atmospheric pollution are the loss of lichens in and around towns and the spread of industrial melanism in moths and other insects.

Spores galore Many organisms rely on the wind to transport them or their reproductive bodies from place to place. At any given time the air is laden with the spores of bacteria, fungi and viruses. These are too small to be seen when dispersed in the air, but you have only to leave some damp bread out for a day or two to discover just how many spores are floating about in the air.

Fern spores and pollen grains add to the living dust in the air. Pollen grains are scattered by conifers and flowering plants, their function being to pollinate the female parts of the flowers and initiate seed formation. It has been calculated that, during the flowering season of wind-pollinated species, well over a million grains of pollen may rain down on each square metre of vegetation. A single birch catkin releases about five and a half million pollen grains, and even a single floret of rye produces over 50,000.

Wind-pollinated trees include hazel, birch, alder, poplar, oak and many others. They usually come into flower early in the year, before the leaves are fully open; otherwise the leaves would intercept too much of the pollen. But the greatest amounts of pollen are shaken into the air in June and July, when the grasses come into flower and cause great distress to hay fever sufferers. Although grass pollen is by far the most abundant and important during the summer, other wind-pollinated herbs contribute to the pollen count, notably plantains and nettles.

Plant parachutes Most seed-bearing plants possess mechanisms for spreading their fruits and seeds well away from the parents – essential if the species is to be able to colonize new areas. The wind is an important agent of dispersal, and many plants possess winged or plumed fruits which can be borne away on the breeze. Familiar examples are the winged fruits of elm, ash and sycamore. Even in still air these glide to earth some way away from the parent trees, and in strong wind they can travel for miles.

Plumed fruits include the parachutes of dandelions and related composite species. Willowherbs, too, release clouds of light, fluffy seeds which can travel immense distances and have been detected many thousands of feet up in the air. However, wings and plumes are not essential for wind dispersal, and a good many plants are able to disperse themselves simply by producing small, light seeds that are easily caught up in gusts of wind.

Above: A flock of pinkfoot geese in flight – these birds do not feed on the wing, using the air rather as a travelling medium to get from place to place.

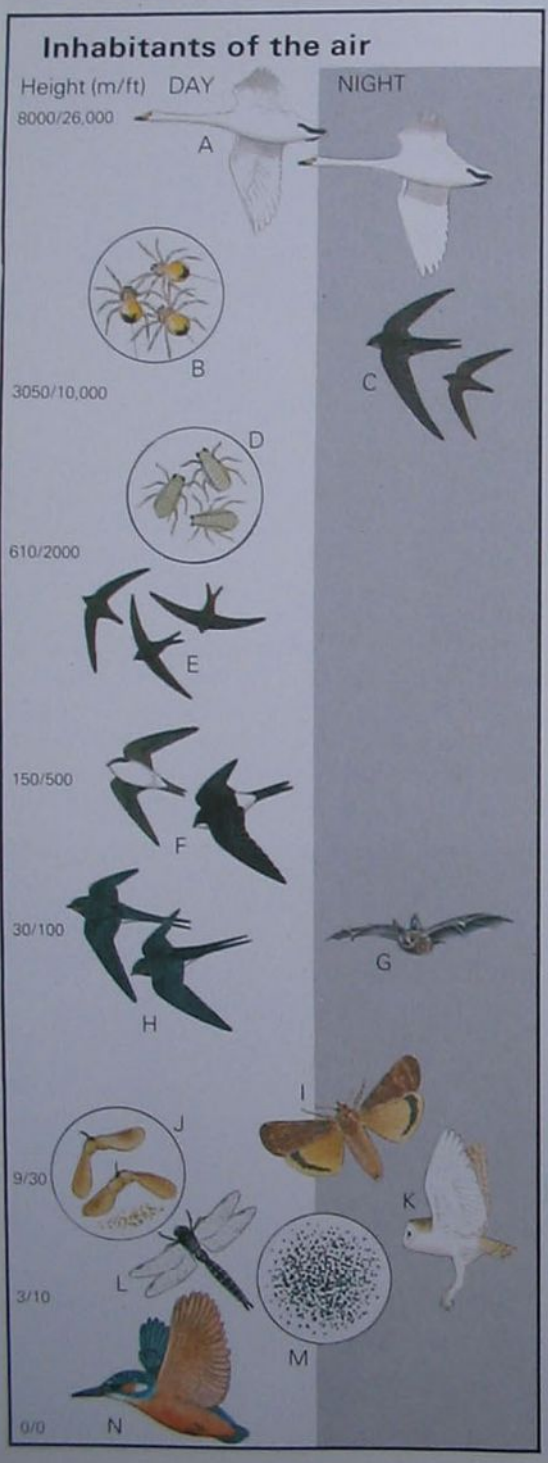
Opposite page: The air is never entirely empty, as can be seen from the motes of dust caught in the light of the sunbeams in this picture. Although traces of atmospheric gases are found as much as 1600km (1000 miles) above the earth's surface, the air thins out rapidly with height and more than half of the earth's atmosphere is held within 6.5km (4 miles) of the surface. Aerial life is even more restricted, rarely occurring more than a few thousand feet above the surface.

Below: Insects like the honey bee are seldom seen far from the plants from which they obtain food.

Animals aloft Although many small animals are carried into the air, just like dust and seeds, only three groups can really fly – the birds, the bats and the insects, the latter being by far the largest group and providing the bulk of food for the other two.

The aerial insects can be split into two sections – the directional fliers, which fly strongly and go where they wish regardless of wind direction, and the weaker fliers which, although actively flying, are carried along at the mercy of the winds. This latter group make up the aerial plankton.

Most directional fliers merely use the air as a travelling medium to get from place to place, good examples being the bees and butterflies that fly from flower to flower. But some insects are more completely aerial. The dragonflies, for example, may spend hours on



Above: The winged 'aeroplane' seeds of a sycamore tree—wind catches these seeds and whirls them for great distances through the air.

Left: **A** migrating whooper swans; **B** spiderlings wafted on silken lifelines; **C** roosting swifts; **D** aphids carried on air currents; **E** feeding swifts; **F** feeding house martins; **G** hunting pipistrelle bat; **H** feeding swallows; **I** yellow underwing moth; **J** winged sycamore seeds, pollen; **K** hunting barn owl; **L** hawking dragonfly; **M** swarm of gnats at dusk; **N** kingfisher.

Below: False oat-grass in flower—millions of grains of pollen are produced by grasses in June and July, to the great distress of people who suffer from hay fever.

the wing, hawking to and fro and catching their food in flight. Swarms of winter gnats and other flies are commonly seen dancing up and down in the air, especially on a winter afternoon. These insects are nearly all males and the function of the dancing swarms is to attract females.

The aerial plankton The insects drifting on the wind are mostly very small species—mainly flies, chalcids and other small hymenopterans, aphids, and thrips. Occasionally there are tremendous 'explosions' of these insects, especially the aphids and thrips, when vast numbers mature and take to the air together in exodus flights designed to take them to new homes.

For instance, large areas of Britain were plagued by swarms of the rose-grain aphid in July 1979. Conditions earlier in the year had been ideal for the development of this species, and adults were so numerous in late July that work had to stop in some factories and dockyards. From information provided by radar and by suction traps it was estimated that about 200,000 tons of these insects were in the air just over south-east England at the end of July—about a thousand million million aphids. Many were carried out to sea, only to be brought back to the beaches as the winds changed, and they were also caught more than a mile up in the air.

Nets towed behind aeroplanes and slung beneath high-flying kites have caught insects at heights of more than 15,240m (50,000ft), but the great bulk of the aerial plankton occurs in the lowest 90m (300ft), and even here there is a sharp drop in numbers as the height increases. Traps 3m (10ft) above ground have caught 540 insects in 10 hours, while similar traps at 90m (300ft) have collected only 80 insects. Numbers also fluctuate with temperature, usually increasing up to about 21°C (70°F) and then falling again. The greatest numbers are aloft during the day, with an almost complete fall-out of planktonic species at night. Summer days clearly

have more insects aloft than winter days.

However, flying insects are not the only components of the aerial plankton. Many wingless insects are swept up by the wind, including numerous small hairy caterpillars which are dispersed over a wide area in this way. Some have been found at 610m (2000ft). Spiders are also abundant in the air – usually youngsters which regularly use silk threads as parachutes to carry them to pastures new.

Birds and bats Apart from the exceptional swarms of insects already mentioned, it has been estimated that some 25,000,000 insects may be in the air over 2.6sq km (1 square mile) of countryside at any given time. Fewer are present over urban areas, but their numbers are still appreciable. These insects form a vast reservoir of food for swifts, swallows and martins – all species which capture their prey in mid-air. It is noticeable that these birds fly higher in warm weather when the insects are higher up.

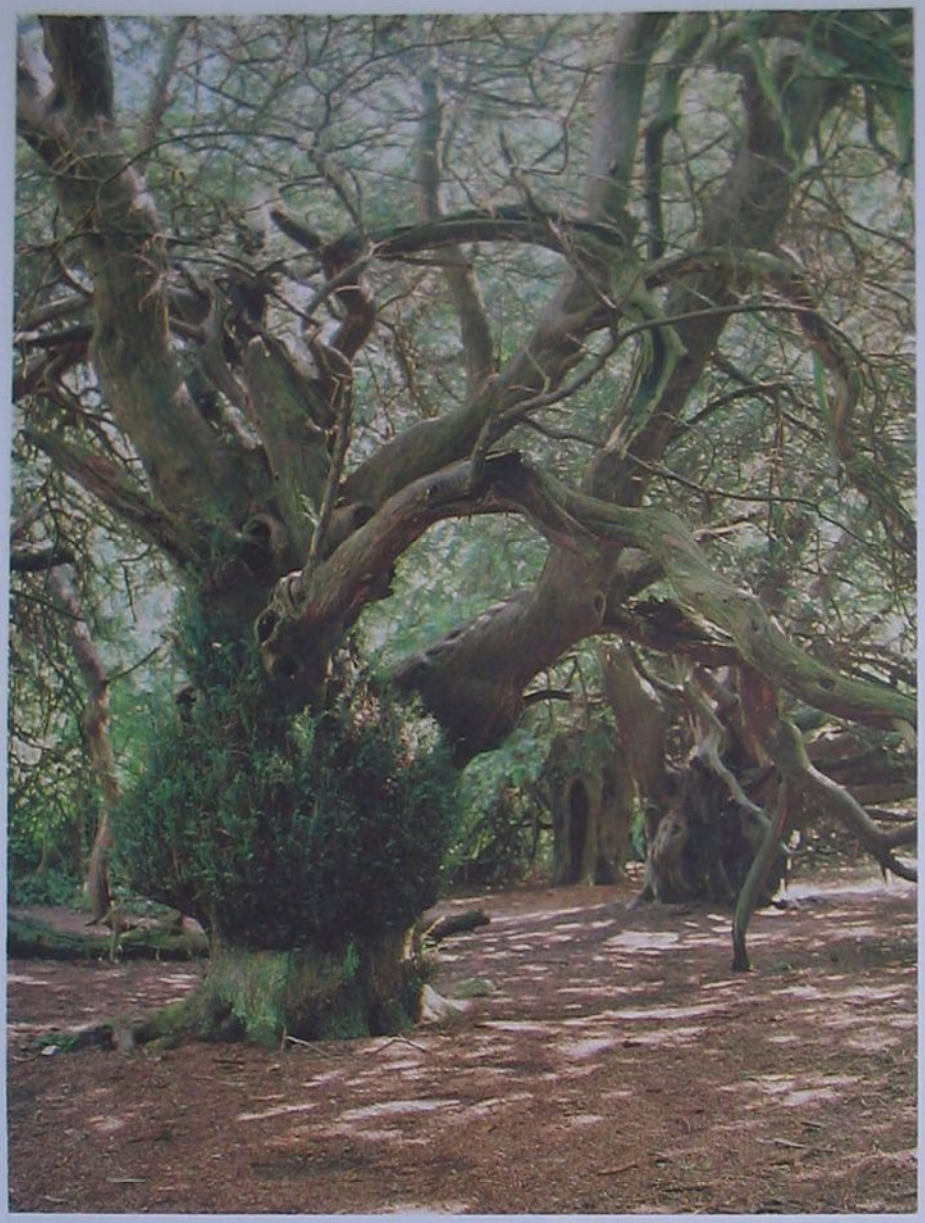
Although the aerial plankton nearly all settles out at night, many larger insects – such as moths and beetles – are on the wing in the dark. They are the major food of the nightjars and bats, that take over from the swifts and swallows as dusk falls.

The birds are, of course, the masters of the air. Most of them spend their lives below the height of 150m (500ft), but migrating birds such as dunlin have been recorded, by radar echoes, flying as high as 7000m (23,000ft), while whooper swans are known to migrate at heights of up to 8000m (26,000ft). Swifts, which fly much higher than the martins and swallows, may rise to 3050m (10,000ft) to spend the night roosting on the wing. By contrast with the heights birds achieve, bats spend most of their lives no higher than about 60m (200ft). The light bodies and feathers of the birds and the broad, leathery wings of the bats, like the gauzy, insubstantial wings of the insects, are specially adapted to support them in the air – the largest single habitat in the world.

Above: Creeping thistles disperse their parachute-like seeds through the air with the help of the wind. Plumed seeds like this have been found many thousands of feet up in the air.

Right: An earth star fungus releases vast numbers of spores into the air in smoke-like clouds after being 'triggered' by a drop of water. Even a falling leaf or a gust of wind can cause such a discharge. It has been estimated that a giant puffball fungus, of about 30cm (12in) in diameter, contains some seven million million spores. These spores can be wafted up to heights of 15,240m (50,000ft) but 95% of them reach no more than 1830m (6000ft).

Right: Male flowers of a Scots pine liberating pollen in clouds. The Asthma Research Council publishes daily estimates in summer so that hay fever victims can plan their days accordingly. A pollen count of under 50 (under 50 grains in a cubic metre of air) is low and few people are likely to be distressed, but a count of more than 100 is high. The problem is worst in country areas, but town-dwellers do not escape entirely – a pollen count of more than 200 has been recorded in some towns in June.



THE YEWS OF KINGLEY VALE

Britain boasts the finest natural yew wood in Europe – Kingley Vale in the South Downs of Sussex, where some 20,000 yew trees, many gnarled and twisted with age into fantastic shapes, are crowded into the Vale's half a square mile.

Above: The trunks of many yews at Kingley Vale grow unevenly and, with age, become twisted into fantastic shapes reminiscent of human faces or mythical animals.

Opposite: A view southwards over Kingley Vale.

Far away from any road on the South Downs of Sussex lies a great valley a mile long and half a mile wide. Shaped like a Roman amphitheatre, it faces south to the sea and in summer the heat reflects from slopes as steep as Scottish mountains. There is no stream here, yet much of this valley is cool because it is covered by yew trees, some twenty thousand in number.

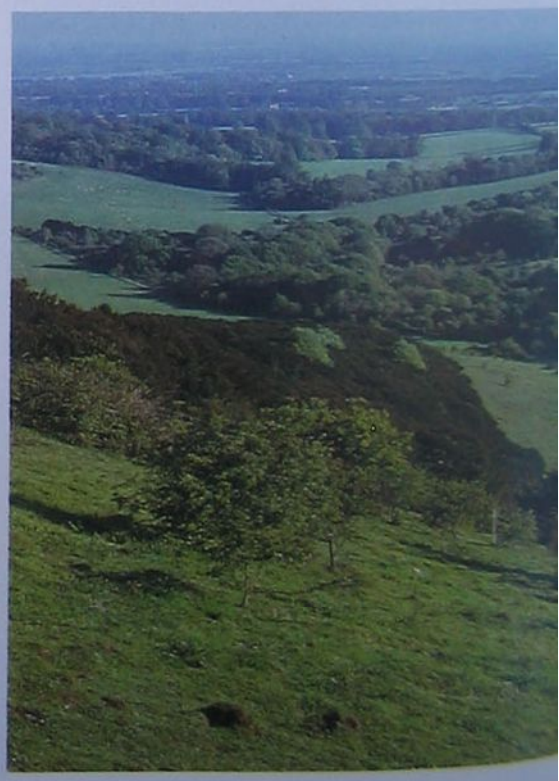
The name of the valley is Kingley Vale, which means 'burial place of kings'. In 1904 a writer described the forests as 'grave and silent . . . transformed at dusk into a sinister and fantastic forest, a home for witchcraft and unquiet spirits.' Even today, many people will not venture into the forest at night.

Ice Age carving The symmetrical horseshoe-shaped valley of Kingley Vale was carved out 10,000 years ago during the last Ice Age, when glaciers moving southwards swept away the top layer of soils down towards the sea, leaving chalk bed-rock exposed on the slopes behind.

Eventually prehistoric man cultivated the valley floor, leaving behind many marks of his occupation: small field banks can still be seen like a pattern on a chess board, as can earth banks with which he fortified the hilltop against invaders. And on the crest of the valley, at a point visible from many miles around, he left his dead kings in tombs which were domed or even pointed like the pyramids. These may well be the kings that gave the Vale its name.

At this stage the 'sinister and fantastic forest' was yet to come, even though the yew is native to the area, for early man, and later the Romans and then the Saxons, all cultivated Kingley Vale. By the 16th century sheep were grazing the downs in thousands, their close nibbling creating a carpet of turf composed of dozens of different species of small herbs and grasses, called chalk turf. Trees and shrubs could not grow in these conditions because they would be bitten as they sprouted from the seed.

Despite the sheep, the earliest map of the area, made in 1726, shows a grove of yew trees in the valley bottom, around which a



sheep fair was held every mid-summer. Legend has it that this grove was planted by the men of Chichester to commemorate a battle fought and won against Viking raiders. It goes on to say that the Viking kings were buried in the Bronze Age tumuli on the hill, which is certainly untrue. So the origin of these trees is uncertain.

Yew life-cycle What is certain is that those 20 or so trees between them gave rise to the thousands of yews now to be found on the slopes of the Vale. This is not so unlikely as it may seem, however, since each female tree can start to produce fertile seed at 25 years of age and may continue to do so for several centuries.

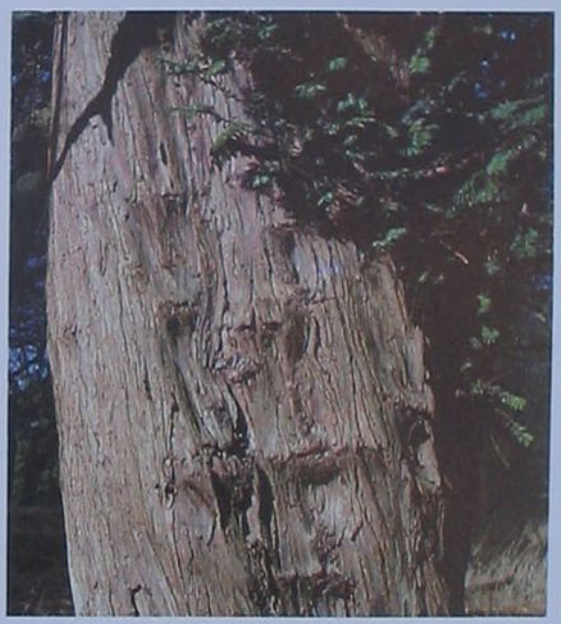
The fruits of a yew consist of a stony pip enclosed within a fleshy red aril. They start to develop as soon as fertilisation takes place in late February. The pollination of the trees is sometimes a spectacular phenomenon. It usually occurs on a dry windy afternoon when gusts of wind catch the crown of the male trees and pull away dense clouds of yellow pollen from the flowers. Sometimes much of this pollen blows away to form a plume like the smoke of a bonfire. In Kingley Vale the male yews outnumber the females by as many as half again and so the latter are liberally covered with pollen. Once this happens, the green female flowers, previously no bigger than a pin head, are fertilised and start to swell, while the male flowers fall and carpet the ground beneath.

Food for wildlife By July the first fruits are ripe but it is not until October that the crop is complete. Mistle thrushes are the first creatures to begin feeding on the glutinous jelly of the arils, when as many as 200 sometimes converge on the valley. Later, fieldfares, redwings and song thrushes in mixed flocks of up to 2000 arrive to feed, and home-bred blackbirds join in as well. These birds appear to extract little nutriment from the arils, which pass through very quickly, or are sometimes ejected via the mouth.

Other animals feed on the arils: foxes do so almost exclusively for a few weeks, passing as many as 250 pips in a single dropping. Badgers chew the whole fruit, seeds and all, and visiting dogs eat the arils too.

Struggle for survival With so many animals feeding on the fruits, the seeds are distributed very effectively through the surrounding countryside. However, it does not follow that a yew wood will necessarily develop. A seed takes 18 months to germinate, if it is not eaten by a mouse, for example, and the seedling, which resembles a tiny palm tree, may last only a few months before being scorched by the sun or eaten.

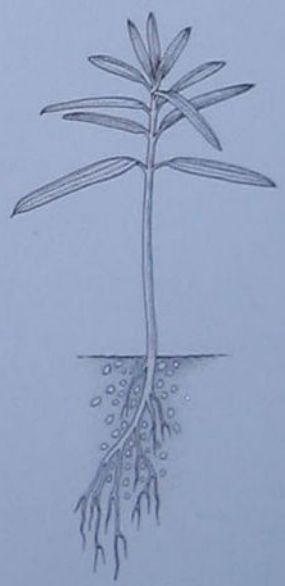
A great many of the seedlings are eaten almost as they sprout, fallow deer being the main culprits today, though sheep were largely responsible in the past. The only likely survivors are those seedlings that land



Above: A great many species of birds can be seen in Kingley Vale, including the tawny owl (shown here), the green woodpecker and the turtle dove. Only six species of birds inhabit the pure yew woods, however, these being the robin, crow, magpie, blackbird, great tit and goldcrest. Populations fluctuate greatly from year to year. Thus the robin increased from 21 pairs in 1975 to 80 pairs in 1981.

Left: The bark of a yew is a distinctive brown, reddish-brown or purplish, flaking and peeling away to reveal patches beneath.

Seedling yew



Above: Unless it is growing within a prickly bush such as a hawthorn, a seedling yew is quickly grazed by a deer or sheep.

Above: In recent years the arrival of fallow deer from nearby woodland has brought a halt to the expansion of the yew forest. Their browsing is preventing young trees from growing, and almost all the yew seedlings are being eaten soon after they appear, only those fortunate enough to be protected by a hawthorn bush being allowed to grow freely. Yet the deer seem to be suffering no harm from the diet of yew leaves. Presumably they have become immune to the yew's poison.

beneath a prickly bush such as hawthorn or juniper. On steep slopes of the valley, these so-called nurse shrubs spread fairly rapidly during periods when sheep grazing becomes less intense for a few years, due perhaps to temporary economic decline or a war. Thus one part of the wood can be traced back to the First World War when the valley was used as a firing range, and there is a much younger area around this that dates back to the last war.

Gradually the yew wood spreads in size, with the younger trees always on the outside. The nurse shrub eventually dies and is overtaken, but its position can usually be seen thereafter, because it will have raised a family of yews. Typically, a family consists of five or six yews standing in a circle and is quite distinct from the next family, which can be 10-15m (30-50ft) away. Some members of this family become dominant, while others are suppressed. In one 80-year-old family of yews that was cut down on neighbouring farmland, the largest tree was 44cm (17in) in diameter and the smallest only 4cm (1½in), yet they were all almost exactly the same age.

This illustrates how difficult it is to age a yew tree, especially the largest specimens. The problem is compounded by the fact that what seems to be one tree may be several trees that have grown together and coalesced into a single trunk.

A halt is called In recent years the arrival of deer in Kingley Vale has stopped the expansion of the yew wood. In 1973, 40 fallow deer took up residence in the Vale when the trees in nearby woodland grew above their browsing line. These deer feed on the yew foliage, sometimes exclusively so and at other times supplemented by local farm crops. The result is that any yew tree shorter than 1.5m (5ft) has not been allowed to grow any higher and most seedlings are being eaten as soon as they germinate. Only those yews protected by hawthorns are growing freely. The deer seem to be suffering no ill effects from their diet and it must be assumed they are immune to the poison in the yew leaves which so quickly kills most other creatures, including humans.

Sheep are still helping to control the spread of yews. They are grazing some 25 hectares (60 acres) of chalk grassland, eating the yew seedlings with no apparent ill effects.

The changing Vale Kingley Vale is continually changing and, in the past 15 years, 600 trees have been lost, most by falling over through snow damage or root slippage. Where these gaps have occurred, heavy browsing has prevented the return of woodland. Instead, the gaps are colonized by grasses and herbs, marking the beginning of a return to the chalk grassland vegetation that used to be there. This natural regression will not be altered by planting the gaps with fenced-off yews; instead the Nature Conservancy Council (which owns most of the reserve) plans to observe and record the changes as they happen.

Research programmes Considerable research is going on into the chalk turf of Kingley Vale to find out whether it is better grazed in the summer or winter, or whether a forage harvester should be used to cut the grass once a year. The latter method seems to benefit flowering plants, though butterflies (Kingley Vale has 39 species, which are monitored weekly) fare better if the turf is used for winter grazing or cutting.

Much of this research work is carried out by the warden, helped by a small team of volunteers. Together they also carry out all the work necessary on a busy nature reserve, particularly in trying to control some of the less desirable activities of the visiting public, such as litter dropping, collecting rare species, digging up wartime relics and allowing dogs to run wild.

The route to Kingley Vale

Kingley Vale lies about 8km (5 miles) north-west of Chichester in West Sussex, the best route to take being the road from Chichester to West Stoke, then to follow the footpath north for about 1.5km (1 mile). Much of the reserve is open to the public, and about 20,000 people visit it each year. Two-thirds of the reserve is owned by the Nature Conservancy Council; the rest is leased to them from The Edward James Foundation, whose estates cover large parts of West Sussex.

— railway

--- public footpath

area of unrestricted access

CLOVERS AND THEIR RELATIVES

A large, colourful group of plants, clovers and trefoils not only brighten our meadows and roadsides but are also an important forage crop.

There are nearly two dozen species of clovers and trefoils growing in the British Isles. Some are so rare and localised in their distribution that few people are familiar with them, whereas others – the white and the red clovers for example – are like old friends. All clovers and most trefoils (bird's-foot trefoil being one exception) belong to the genus *Trifolium*, a name that refers to the fact that their leaves are divided into three leaflets. The genus belongs to the pea family.

Clovers have been familiar to country people for many hundreds of years. The word clover was originally the Old English 'claver', a name that is still preserved in such place names as Claverdon – meaning clover hill – in Warwickshire.

In folklore, to find a four-leaved clover instead of the usual three-leaved ones is considered lucky, provided it is found accidentally; the charm does not work if you search for one. Particularly lucky are four-leaved forms of the plant known variously as the lesser yellow trefoil, lesser yellow clover, lesser hop trefoil or shamrock. This plant is supposed to be the true shamrock, the emblem of Ireland, the wood sorrel being a recent pretender to the title. The word shamrock, coming from the Gaelic 'seamrog', meaning a little clover, seems to support this.

Weak-stemmed plants Both clovers and tre-

Above: Two of Britain's most common clovers, the white clover (*Trifolium repens*) and the red clover (*Trifolium pratense*), are often seen growing together in meadows, roadsides and other grassy areas. Also known as the Dutch clover, the white clover is a perennial plant whose stems creep along the ground and take root. It flowers between June and September, its white flower heads being borne on stalks that arise from the leaf axils. The flower stalks are between 5cm (2in) and 20cm (8in) in length, which is long for a clover. The red clover has a slightly longer flowering period, from May to September, its flower heads being more or less stalkless.

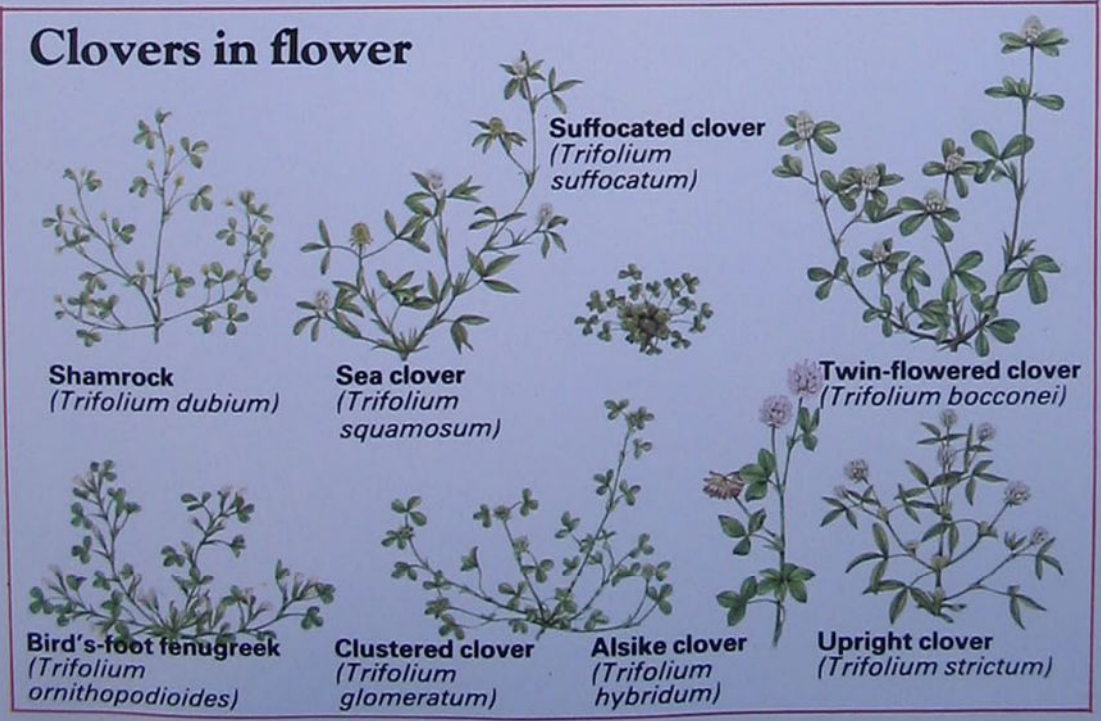
foils are small herbaceous plants with slender stems that often lie close to the ground or rely on other plants for support. The flowers are gathered into dense racemes, which grow on short stalks or are sessile (stalkless) and borne in the leaf axils.

Generally speaking, clovers have white, red or pink flowers while trefoils have white or yellow flowers, but the division of *Trifolium* species into these two groups is entirely artificial.

Despite being members of the pea family, clovers and trefoils may not at first glance seem to have typically pea-like flowers. Most pea flowers consist of a large rear petal (called the standard), two wing petals and two basal petals joined to form a keel. This arrangement can be seen very clearly in, for example, the sweet pea, but in *Trifolium* species the petals are modified, all five being joined together along about two thirds of their length to form a tube. In addition, of the ten stamens found in all flowers of the pea family, nine are fused to the petals in the clovers and trefoils.

Reaching for nectar The narrowness of the tube plays a crucial role in determining which insects can reach the nectar secreted at the base, and thus which ones can pollinate the flowers. Attracted by the nectar and the scent of the flowers, insects (mainly bees) try to push their way into the tube but fail because of its narrowness. Instead, they must resort to using their tongues. Since different insects have different lengths of tongue, clovers with long-tubed flowers can be pollinated only by insects with the longest tongues, whereas those with short-tubed flowers are pollinated by a much greater variety of insects. Conversely, insects with long tongues have a much wider range of flowers on which to feed than do insects with short tongues.

Clovers in flower



Above: The hare's foot or hare's-foot clover (*Trifolium arvense*) is an erect plant growing to a height of 20cm (8in) and is unusual among clovers in being an annual. Its name comes from its soft, white, downy flower heads, which resemble a hare's foot in both shape and texture. They appear between June and September on short stalks. It is a weed of sandy fields and heaths, especially near the coast, and is fairly common in England, especially eastern and south-eastern parts, and Wales, though it is rare in Scotland and Ireland. It used to be more common on arable land than it is now, but has declined with improved farming methods.

The honey bee, for example, has a short tongue and is forced to obtain most of its nectar from the white clover, which has small flowers with short tubes. For this reason, the white clover is a very important plant for the honey industry, and it is also valued by farmers who grow it as a forage plant. The wild plant is very common in Britain, growing in lawns and meadows and by roadsides.

Long-tubed red clovers Along with the white clover, the other extremely common species of *Trifolium* is the red clover. This grows wild in grassy places all over the British Isles and, like its white companion, is an important forage crop for farmers. However, it is much less important for the honey industry because its long-tubed flowers usually place the nectar out of the reach of honey bees.

Instead, the red clover is pollinated by bumble bees. These bees nest mostly in woodland or hedgerows and, in recent years, it has become evident that red clover crops do not produce high seed yields unless they are grown near suitable nesting sites for the bumble bee. As much as three times the weight of seed may be harvested from a field near a wood as from one in the open.

One species of bumble bee has learned to rob the long-tubed clovers of their nectar. Called the robber bumble bee, it has a short tongue and cannot reach down the tube as far as the nectar. However, instead of moving on to a short-tubed species, it pierces a hole in the bottom of the tube and steals the nectar without pollinating the flower!

Crop clovers White and red clovers are not the only species of *Trifolium* to be cultivated. Alsike clover is often grown with grass as part of the hay crop, while crimson clover is grown in southern Britain as a catch crop after the cereal harvest.

The Alsike and crimson clovers are both potentially useful nectar producers for beekeepers, especially the crimson clover because its flowering period, lasting through May and early June, covers the gap between the last of the fruit blossom and the beginning of the white clover season. At present, however, neither species is fulfilling its potential for honey production because both crops are cut while they are still green and in full flower.

Clovers as weeds Not all clovers are useful to man. Many, together with some of the small trefoils, grow unnoticed in grassland and hedgerows, while others are weeds. The hare's foot, or hare's-foot clover, for instance, grows as a weed in sandy fields or more commonly on sandy heaths, often accompanied by another *Trifolium* species, bird's-foot fenugreek, so-called after the shape of its seed pods. Both have pinkish flowers but those of the hare's foot are clustered in the usual pattern of clover flower heads, while those of the bird's-foot fenugreek are borne singly or in small clusters of up to five flowers.

Some of the rarest clovers are found near the sea in southern England, for example the sea clover, which is found in grassy places near saltmarshes. The Lizard cliffs in Cornwall are the home of two rare species, the upright clover and the twin-flowered clover. Two more, the clustered clover and the suffocated clover, are distributed more generally on light sandy soils near the southern coast.

The trefoils, such as the hop trefoil, are common in grassy places all over the British Isles, and may even be found on coastal sand dunes. This species has the yellow flower head typical of trefoils but others have white or creamy flowers, for example the rough trefoil and the subterranean trefoil. Both are usually found only on dry sandy grassland, usually close to the sea.

Right: The crimson clover (*Trifolium incarnatum*) is one of the most distinctive clovers, its elongated flower heads growing up to 4cm (1½in) long, with deep crimson flowers, being quite unlike those of any other clover. It flowers between June and August and, like the hare's-foot clover, is one of the few *Trifolium* species to be an annual rather than a perennial.
This species is not native to the British Isles. It was introduced here from the Mediterranean region and is cultivated in southern Britain as a catch crop to follow the cereal harvest.

Above: Clovers with yellow or lemon flowers tend to be called trefoils (a corruption of the generic name *Trifolium*), though this is by no means a 'hard and fast' rule. An example is the hop trefoil (*Trifolium campestre*), so-called because its brown fruits bear some resemblance to hop cones. This is a common species on dry grassland, roadsides and hedgebanks. Its flowering period is between June and September, the flower heads being borne on short stalks.

Above: The ghost moth (*Hepialus humuli*) is normally seen flying around just after sunset, but if you search carefully in the daytime you may find one hiding among the plants, like this female. To protect herself from birds she remains so still that from a distance she resembles a withered leaf. However cautiously you approach her she will almost certainly disappear, either by falling into the vegetation, as if dead, or by rapidly flying away.

'SWINGING' SWIFTS

You are most likely to see one of our five species of swift moth fluttering around the garden on a warm evening in June or July, soon after the sun has gone down.

The 'swifts' (family Hepialidae), a primitive family of moths which includes the well-known ghost moth, are renowned for their small tongues and unusually short antennae. Although they are most strongly represented in Australia, where some species have wingspans as great as 18cm (7in), five particularly attractive species do occur in Britain and Ireland.

Silvery-white ghost On a warm July evening soon after sunset, but while it is still light, you can sometimes see a silvery-white moth swinging to and fro over flower-beds looking remarkably ghost-like. This is the male ghost moth, so named after its colouring, and mode of flight which resembles a swinging pendulum. The female is quite distinct from the male in both appearance and flight–her wings are yellow with orange markings, and she has a direct flight path, unlike that of her swinging partner.

An interesting variation occurs in the Shetland Islands; here some males have brownish orange markings on their forewings and dark hindwings, while others closely resemble the mainland females. The significance of this departure from normal colouring is not fully understood, but one possible explanation is that, since the Shetland race evolved in isolation, and at high latitudes where the July nights are short and the vegetation scarce, the all-white males developed their colouring to blend with the different environment.

The ghost moth occurs all over the British Isles and is abundant in a variety of habitats–graveyards, gardens, fields, woods, and even urban wasteland where a luxuriant growth of weeds provides ample camouflage. Here the adults are sometimes found by day, resting on the vegetation–the male looking like a piece of white silk caught on a plant and the female resembling a withered leaf. If disturbed they fall to the ground and feign death by keeping completely still.

Underground caterpillars In most moths the courtship ritual commences when the male is attracted by the female's scent. In ghost moths however, the contrary happens, with the female playing the role of the persistent chaser, attracted by the male's scent which is said to resemble the smell of a billy goat.

Following courtship and mating, the female scatters her eggs haphazardly over the vegetation, usually in July. The caterpillars soon hatch and begin feeding on the roots of almost any herbaceous plant, attacking garden varieties and crops as well as wild species. They slowly grow through the autumn and winter and are not fully developed until the following May. They spend all their life underground, so you are unlikely to see them except when digging up plants in the garden.

The pupae also stay underground, in flimsy cocoons constructed of silk and soil particles. Unlike most moth pupae they are active and wriggle violently if disturbed. In

June fliers

Above: **Orange swift** (*Hepialus sylvina*). Common in gardens.

Below: **Map-winged swift** (*Hepialus fusconebulosa*). Heathland in north.

Above: The common swift moth (*Hepialus lupulina*) can claim two distinctive features—it is the commonest member of the swift family and also the most sombre. Both sexes are a drab dingy brown, although the male (above) has distinguishing white blotches on his forewings.

Left: If you spot a male ghost moth on a warm summer evening just after sunset, you will realise how its name originated—the silvery-white form and flight, which is reminiscent of a swinging pendulum, give the moth a ghost-like appearance, particularly in graveyards where it is fairly common. The male is quite unlike the female which has yellowish wings with orange markings, and flies directly rather than swings to and fro.

Above right: The vividly coloured male gold swift moth (*Hepialus hecta*) emits a distinctive scent, not unlike the smell of a fresh pineapple, which attracts the much duller female from considerable distances.

contrast to the larval stage the pupal stage lasts only a few days, during which the pupae work their way to the surface before the adults finally emerge.

Sombre swift By far the most abundant member of the Hepialidae is the drab-looking common swift. If you are lucky you may see hundreds of this species flying at headlong speed through the vegetation on warm summer evenings in June, and sometimes as late as September.

The caterpillars are white and live underground where they feed on the roots of grasses and other plants throughout autumn and winter. Since they exist in such large numbers, the damage they cause to roots and consequently grassland can be so extensive that they are sometimes considered as field and garden pests.

Gaudy males The orange swift is an altogether more attractive looking species; the male has bright orange forewings with white bars, while the larger female is brown with deep chocolate-brown and whitish markings on her forewings. The caterpillar takes about two years to mature, reaching full size in the autumn. It then overwinters in the soil and pupates the following spring.

The gold swift is more common in woodland, but only if there is an abundance of bracken—the caterpillars feed on the roots, taking two years to mature. The male gold swift is similar to the male orange swift. The female is similar to the male but duller.

Unfortunately gold swifts are not as common as the previous three species, although they occur throughout the country and are not difficult to spot in June when they are on the wing, the male flying in the same unmistakable swinging manner as the ghost moth.

Map-like moth The last species, the map-winged swift, is found throughout Britain although it is more common in the north. Its name comes from the pattern on its wings—certainly the most intricate of all British swifts, although it is hardly map-like.

The yellowish-white caterpillar, another bracken root feeder, is fully grown in May and the adult moth flies at dusk in June and July.

Caterpillar colouring

The caterpillars of the ghost (right) and other swift moths are whitish in colour. They feed underground on roots, concealed too deep down for most predatory birds to locate. They have no need for the protective colouring found in the caterpillars of many species living above ground. Above-ground caterpillars are either cryptically coloured for camouflage or are boldly coloured and conspicuous to advertise the fact that they are distasteful. Camouflaged caterpillars usually escape detection by day unless they give themselves away by movement, and normally feed safely and unseen by night.

TOO MANY MAMMALS IN THE WRONG PLACE

Although no lover of wildlife likes to contemplate killing mammals deliberately – with the possible exception of rats and mice – there are circumstances when unacceptably high populations cause damage and have to be controlled by culling, trapping, poisoning or biological methods.

Above: The fox is a minor predator of poultry and is accused of killing lambs. It is probably the most important predator of the pheasant, but gamekeepers may be prevented from killing it as their employers may also enjoy hunting.
Although the present number of foxes does not cause alarm in the countryside, there is no doubt that the increasing population of urban foxes, breeding in back gardens, derelict land and cemeteries, and along disused railway lines, provides a much more difficult problem. If rabies reaches Britain, foxes in the infected area would have to be exterminated.

The Oxford dictionary defines a pest as a 'troublesome or destructive animal or thing'. This suggests that man is the most serious vertebrate pest, and well he may be, for he wastes the world's resources and damages the environment. However this article examines other species of British mammal pests.

What is a pest? We do not all agree which animals are pests and which should be protected and encouraged. Even cats and dogs, treasured pets of their owners, are often hated and persecuted by their neighbours when their gardens are invaded.

In the past gamekeepers slaughtered hedgehogs and moles unmercifully, although they did no harm to game. Owls and kestrels

which, by eliminating rodents that competed for food, were often beneficial to pheasants and partridges, suffered equally seriously. Many species are only considered to be pests when they become too common. Thus roe deer are welcomed in small numbers, but when they become too numerous their damage to trees cannot be tolerated and they are then culled by foresters.

Rodents The common, or brown, rat is probably our most serious pest. It carries several diseases that infect man, and destroys millions of pounds worth of food in warehouses and on farms. Although this species is a comparative newcomer to the British Isles, it is well-adapted to town and country living, infesting refuse tips and farms in substantial numbers. The black or ship rat is another newcomer, though it has been with us for about 700 years. It is now much rarer than the brown rat, living mainly in tall buildings, including high-rise flats, especially in ports. The house mouse is a well known pest of town and country, including fields and woodland. The wood mouse, or field mouse, does little damage to crops but is a nuisance when it invades rural dwellings in cold weather: it climbs quickly to attics where it may remove insulation from water pipes.

The field vole sometimes increases its numbers to plague proportions and may ruin patches of grassland or cereal crops. Our largest rodent, the coypu, a native of South America introduced for its fur, is a pest in East Anglia where its grazing damages crops and its burrowing destroys river banks. Porcupines, escapees from zoos, have become established in the past in Devon and Derbyshire, and their damage to trees has caused concern to the Forestry Commission.

Other pests Our largest carnivores, the wolf and brown bear, were exterminated in medieval times when they became unacceptable pests. Although some naturalists have suggested re-introductions, this would be unwise in our crowded island. These large animals could be dangerous to humans, and carry rabies, and damage to domestic livestock would be inevitable. The fox and badger are pests in some areas, and rabbits can cause serious damage to crops. The habit hares have of biting off the top of young trees can be harmful.

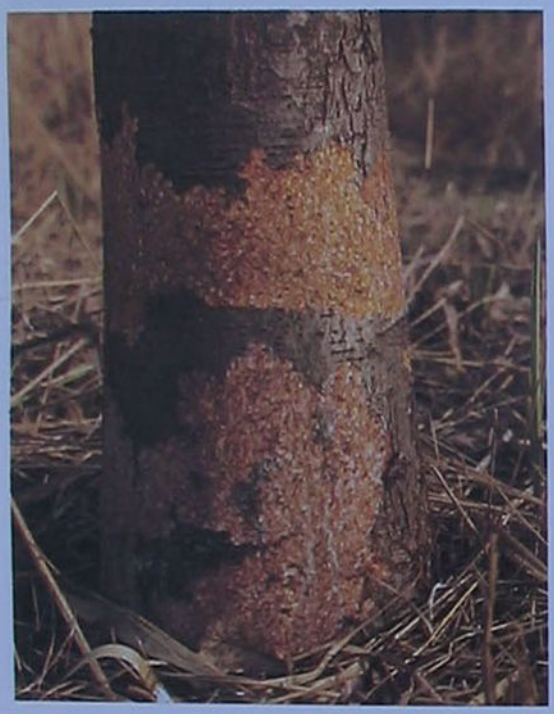
Above: Young badgers making a rare excursion during broad daylight. The badger is a protected species but it may be killed in areas where it is associated with the spread of tuberculosis in cattle. Investigations have shown that badgers are highly susceptible to bovine TB. They probably caught the disease from cattle in the first place, and in recent years they have been killed for passing back the infection by contaminating grazing land with their urine and faeces.

Below: A frustrated rabbit trying to reach a crop which has been protected by wire fencing.

Stoats, weasels, polecats, pine martens and wild cats are still considered as 'vermin' by some older gamekeepers and they have been harried almost to extinction. Like hawks and falcons, these small predators generally kill more troublesome rodents than game birds. The otter was persecuted by fishermen but is now so uncommon that most efforts are devoted to its conservation. The mink, on the other hand, is a potentially serious pest. It is an exotic species, an escapee from fur farms, and its numbers are increasing alarmingly along many British rivers.

The importance of introductions Mammals which are considered important pests have mostly been introduced by man either intentionally (rabbit, grey squirrel) or unintentionally (rat, mink, coypu). While our truly indigenous species are generally adapted to their environment, either maintaining constant numbers over some years, or, like the vole, only increasing when food allows, these introductions have found unoccupied niches which allow them to spread and increase to plague levels, and to remain at high levels even when every attempt at control is made.

Control or extermination? It is important to distinguish between culling an animal population – removing surplus numbers so that the remainder is in balance within the habitat – and attempts at total eradication. The fox has to be culled in some areas because there is not enough of its natural food and so it takes farmstock. In English counties where land is intensively farmed and foxes' earths



Above: Molehills in Surlingham, Norfolk. The mole is a nuisance, rather than a serious pest; it damages the turf on lawns and golf courses, its burrows may uproot small areas of growing crops, and intense burrowing activity may cover substantial areas of grass with molehills, which reduces their grazing value and introduces unproductive weeds.

Left: Apple bark which has been gnawed by a bank vole. Other mammals that attack orchards include field voles, deer, hares and rabbits. Modern orchards are often wired against rabbits, and individual trees may be 'ringed'.

exist only in the few remaining copses and rough areas, extermination would not be at all difficult as the location of every earth is known and could be gassed over a short period. Foxes are difficult to shoot and supporters of hunting claim that the culling of a few foxes in each area is a method of fox conservation: it limits the population and so prevents extensive damage, at the same time ensuring that numbers remain sufficiently high to make further hunting worthwhile for those who enjoy it. Grey seals are culled in the Orkneys under the Conservation of Seals Act 1970. The rate of hunting is considered by scientists to allow a gradual rise in the population.

Most people, and particularly public health authorities, would like to exterminate rats completely, and great efforts have been devoted to that end, but with little success. The Ministry of Agriculture tried hard, and unsuccessfully, to eliminate the introduced coypu from East Anglia. On the other hand, populations of genuine native mammals, particularly carnivores, have decreased catastrophically as modern farming techniques and the increasing use of the countryside reduces the areas of suitable habitat. It is ironical that it would probably be easy to eliminate the mammals we most wish to retain, and virtually impossible to eliminate totally those of which we wish to see the last.

Methods of control Several methods are used to kill pests. First, traps have been produced for most species, and used with varied success. Some pests are also shot. Secondly, chemicals have generally achieved the best control, either as poison baits or as gases. Thirdly, some attempts have been made to use living organisms, viruses or bacteria, or even to introduce other mammals which are predators on the pest species. Fourthly, attempts have been made to make the habitat less attractive. Where this has meant reducing

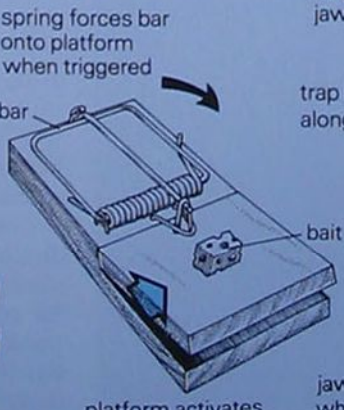
Trapping mammals

Longworth trap
for catching small mammals alive

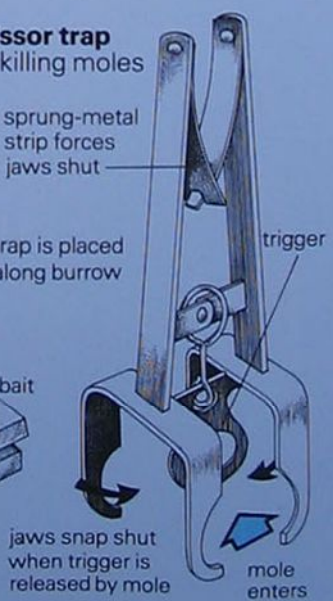
nest chamber is inclined to prevent flooding
lever holds door open until it springs shut as the animal touches a trip-wire at the end of the entrance tunnel
trap door
bedding
food
entrance tunnel is flat on the ground

section through trap

Nipper trap
for killing rats and mice



Scissor trap
for killing moles


sprung-metal strip forces jaws shut
trap is placed along burrow
trigger
jaws snap shut when trigger is released by mole
mole enters

In Britain we have now banned the use of the crueller traps, and only allow those which (usually) kill instantly, like the break-back mouse trap, or the scissor trap used for moles. We also allow traps which capture alive: the Longworth trap, used in the study of small mammals, is baited with grain and gives the captured mouse an easy meal, which is perhaps why those that are released are often recaptured and may even become 'trap-addicted'. Although trapping is of limited use as it seldom eliminates pests it is likely to continue.

the amount of available food, it has been reasonably successful.

Traps Although numerous different animal traps have been developed throughout the world, they have seldom controlled any pest successfully. Traps have been useful in cropping fur-bearing mammals, and snaring provided poachers with welcome rabbits for the pot. If, as commonly happens, only one or two house or wood mice invade a dwelling, they can be trapped and the building is free from those pests until the next time.

The Ministry of Agriculture mounted an intensive campaign using cage traps which caught coypus alive. At first this was thought to be successful in exterminating the pest, but we now know that this method did not succeed, although numbers were greatly reduced and damage became, temporarily at least, negligible. Many traps were very cruel. The gin trap, now illegal, caught the animal by the leg so that it could not escape. Most animals suffered lingering deaths; some even escaped by chewing through their own limbs.

Poisons Poison baits can be very effective, at least over limited areas. Thus worms treated with strychnine and introduced into mole burrows can exterminate the moles locally, though re-invasion will probably occur within the next two years. No other poison has been found to be so effective as strychnine which is, unfortunately, a very inhumane chemical–poisoned moles take about 20 minutes of writhing to die. Regrettably, though attempts are made to restrict the use of strychnine, much of this poison is used illegally to treat carcases which are then consumed by foxes, badgers and birds, as well as by cats and dogs.

Other poisons which are thought to be inhumane have been banned, and anti-coagulants such as Warfarin are widely used, particularly against rats. However, some strains of rats immune to Warfarin have appeared, and other chemicals, some of which may be less humane, have to be substituted. Warfarin is now used against grey squirrels, and special containers are used to try to exclude birds and other mammals and so prevent them from being poisoned as well.

Biological control The introduction of myxomatosis in 1953 proved to be the most successful case of biological control as it eliminated rabbits from many parts of Britain. However many people were disgusted when they saw the affected animals, and the deliberate spreading of the disease was made illegal.

Can mammal pests be controlled? Pest control is clearly difficult, though essential. In food warehouses, rats and mice can be eliminated if no spilled food is available for them to eat. Trapping or poisoning may be useful if an invasion of animals from outside cannot be prevented, although it is much better to render buildings rat-proof in the first place.

Above: The house mouse is common both in towns and country where it can survive in arable fields and woodland. It damages man's food, eating some and spoiling much more, and it ruins books and papers, tearing them up for nesting material. It is particularly dangerous in houses that have old-fashioned electrical wiring, for it is capable of chewing through cables and making the wiring unsafe.

With rabbits myxomatosis is now endemic in Britain, but the virus is less lethal today so elimination this way is unlikely. Gassing of rabbit burrows when numbers increase unacceptably is probably the best policy. It is probably best to tolerate most other pests, unless numbers become too high, when trapping and poisoning, both inefficient methods, may at least temporarily reduce damage to non-economic levels.

Right: A beech sapling protected from rabbit damage. The rabbit was introduced to the British Isles by the Norman invaders about 800 years ago. Until 200 years ago it lived mainly in semi-captivity in managed warrens, but then became common and did much damage to farm crops. In 1950 it was considered to be the most serious pest of agriculture. Rabbits were drastically reduced by myxomatosis in 1953.

NATURE FIGHTS BACK

It is often said that nature today is on the decline. In part, this is true–but some of our bird species prove the generalization to be false.

A glance at almost any daily newspaper reveals an account of some form of wildlife that is threatened with extinction, or some area of countryside is about to be lost to urban or industrial spread. In the media in general, the impression is commonly given that a wide range of habitats and species–even the majority of them–are in serious decline, with such headlines as 'Britain's declining heathland' or 'Census assesses cirl bunting decline'.

While the implicit caution contained in this message is always welcome to the naturalist, some questions arise from it. Are all aspects of wildlife in decline in Britain? If not, which parts of our natural environment are out of danger? In this article, we look at some of the processes taking place in the countryside that affect bird life; and we attempt an overall assessment of the success or otherwise of birds in Britain and Ireland today.

Human pressures Man is often thought of as the main enemy of wildlife; and there are many obvious ways in which industrial development has influenced the environment in ways harmful to wildlife. Farming, too, provides examples: vast expanses of cereal monoculture certainly do not harbour many wildlife species. Grassland, in the hands of the modern farmer, is also an impoverished habitat. Improved hay crops, the use of green-cut grass for silage, earlier growing seasons and more efficient mowing have all

Above: Gulls foraging on waste discharged from a Shetland fishing boat. Arch exploiters of man, most gull species have increased in numbers dramatically during the present century. They also find plenty to eat inland, at the rubbish tips of their unintentional benefactor, man.

Below: Golden eagles at the eyrie. These birds of prey are given special protection under the Wildlife and Countryside Act–and they certainly need it.

but eliminated the corncrake, to mention just one example.

Other pressures arise more from wrong thinking than from efficiency. In the Highlands and Islands, many shepherds still believe that golden eagles are ferocious lamb-killers. This fear, though exaggerated out of all proportion, results in an annual toll of poisoned eagles and nests set on fire.

A longer view There are, however, good reasons to be cautious in making a general judgement on the decline of wildlife at man's hands. We have to remind ourselves that even today's accumulated mass of records of bird observations covers only a tiny portion of historical time. Farming may be cast in the role of a villain today, yet go back a thousand years: how many bird species were present then? Britain and Ireland were almost entirely covered in forest, unlikely to have held the numbers of species (or of individual birds) that can be found today. Since then, agriculture has spread, removing the ancient woodlands–and creating the right conditions for today's rich bird fauna. Many of the thrushes, tits, warblers and finches thrive best of all in forest edges, clearings and hedgerows, and are here because of farming, not in spite of it.

Regular cycles There is another caution to remember: sometimes wildlife species give the impression of being in decline, only to recover again after a number of years. Bird-watchers have recorded their observations, often in great detail, since before Victorian times. Looking over the records, we can recognise a number of cyclical patterns. The Victorians, for example, would have been astonished at the frequency with which we see great spotted woodpeckers; for them, the 'usual' spotted woodpecker was the lesser. Early this century the situation changed–the great spotted began to become more common, and the lesser grew scarcer. This continued until the 1960s, when the lesser once again started to increase in numbers.

There are other cycles of a shorter duration: wood warbler, chaffinch and greenfinch numbers fluctuate regularly in cycles lasting only a few years. The explanations for such patterns, however, are by no means easy to find.

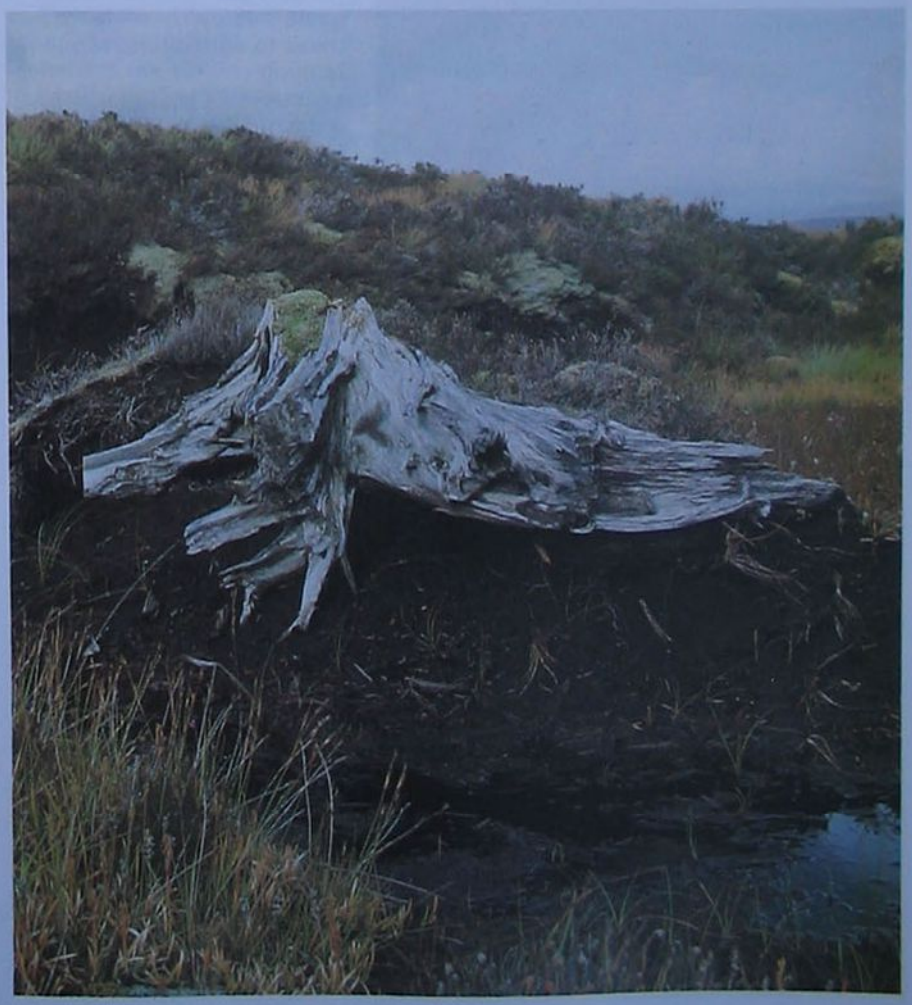
Disaster and recovery Nature also has its calamities, which may suddenly produce a huge decline in bird numbers–only for a recovery to occur, usually within a year or two. The most obvious cause is a severe winter, and the wren is the best example of a victim. Another disaster affected the whitethroat population, which departed on its autumn migration in 1968 in its normal numbers–only about one third of them returning the following spring. The cause was eventually traced to a drought in the whitethroat's wintering grounds on the southern fringe of the Sahara. Slowly, over perhaps as many as a dozen years, the whitethroat has recovered its numbers. In fact, the populations of most small birds appear to be at least stable or fluctuating about a norm, and a few are showing a steady increase.

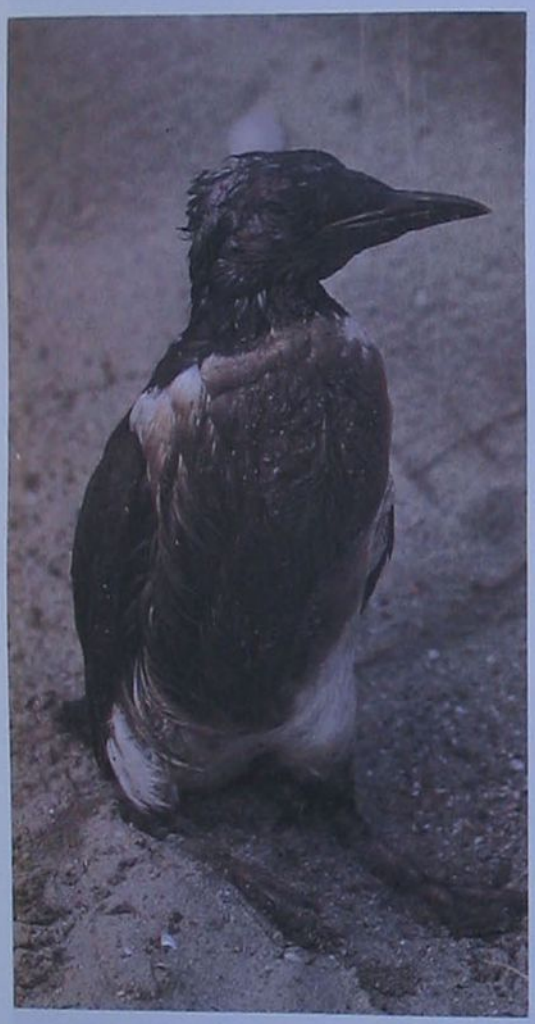
Nature's resilience In view of the hazards they face, we are bound to admire the great natural resilience birds demonstrate. The long-tailed tit and the wren accomplish a rapid recovery every time their numbers are depleted in the icy conditions of an exceptionally bad winter–their secret lying in over-production of eggs and young, which creates a 'cushion' of surplus birds with more chances of individual survival in the event of a disaster.

Excellent recoveries have been achieved by the great crested grebe and the kittiwake, struck by disaster in the late 19th century

Above: Wrens raise large numbers of chicks each season. When savage winter weather affects a large area, their numbers drop by 70-80%–but the excess number of chicks helps to ensure a return to normal numbers in about three years.

Below: In the 18th century this Highland area was a pine forest, as the remains of a stump testify. Large-scale clearance has left a mixture of open moors and broken-up forest–richer in bird life.





Above: Cetti's warbler, a colonist from the Continent.

Left: The wreck of the supertanker *Amoco Cadiz* in 1980 spilt harmful oil in the waters off Brittany, resulting in thousands of oiled seabirds like this guillemot. Often the injury is fatal and many birds were lost. But the seabirds showed their resilience: research has shown that numbers were not permanently affected by the tragedy.

Below: One of the losses to weigh against the historical gains that our bird life owes to agriculture. Modern farming creates an environment that is unfavourable to birds. Here a farmer applies a chemical spray. Herbicide and non-selective insecticide spraying programmes eliminate or reduce all wild plants, not just the harmful competitors of the crop plant; and they harm all insects, not just those that damage the crops. This makes the field uninhabitable – there is just not enough for wildlife to live on.

when a generation of Victorian fashions dictated that these birds be shot to provide hat feathers. Once the shooting was stopped by bird protection laws, both species returned from the brink of extinction to attain healthy numbers.

New opportunities Not only are bird species resilient, they are great exploiters of any change that might be turned to their advantage. Species beginning to colonize southern England include some for whom the milder climate prevailing since the 1950s has made Britain a more suitable habitat. Savi's and Cetti's warblers are now colonists of this kind, increasing their range from the Continent. For other species, however, the changing climate has been unfavourable: it is one of the factors that has been causing the cirl bunting and the red-backed shrike to 'retreat' in the opposite direction for some decades now.

Change of a different kind provided an opportunity for the black redstart, a species that colonized the rubble of blitz-torn London during the war because this resembled its mountainside scree habitat. Other changes – the growth first of the whaling industry and then of the fishing industry (and fish processing at sea) were exploited by the fulmar, which has multiplied its numbers during this century, thriving on the waste from these human activities.

Moving populations The avocet, the fieldfare and Savi's warbler are among many species that show another feature of bird behaviour that contributes to a slight overall 'improvement' in the richness of our bird fauna. These birds are engaged in a Continent-wide expansion drive. This process – which also occurs in the reverse direction, with birds undergoing a Continent-wide retraction – cannot be explained in simple terms. Agricultural change and other human factors, as well as climate, can be cited as partial causes, but the entire picture is highly complex. One has to take into account the fortunes of other bird or animal species that compete with the bird for food or habitats. There is also the fact that the decline of one species affects any predatory species that depend on it as a food supply. Our natural environment is always changing, and so all wildlife is bound up in a constant interplay of gains and losses – with the gains, in Britain in recent decades, slightly outweighing the losses.

Overall picture In conclusion, it can be said that there are many healthy, even growing populations of bird species in our countryside. These include seabirds, geese and the smaller birds that thrive in our pattern of broken-up woodland habitats. This does not imply that conservationists can relax – if they did, the situation might change rapidly, for all that we have said here still leaves the future an entirely open question. Conservation will still be necessary for years to come.

Changes in bird populations

Each of the birds shown here is an example of one of the main causes of population change taking place in our countryside. These include climatic change, changes in human activities such as farming and fishing, genetic change and changes in competition and the ecological balance. Bird populations also shift their geographical range within Europe; also, a boom in a neighbouring country can create an influx of 'pioneers' in Britain.

Birds on the increase

Collared dove: genetic change to a migratory pattern of behaviour; expansion in Europe.

Osprey: a change in North Sea winds brought migrating ospreys to Britain; RSPB-protected.

Savi's warbler: gaining after period of absence from Britain/Ireland; European expansion.

Little ringed plover: increase in sand and gravel extraction gave more nesting sites.

Pink-footed goose: has trebled its numbers, thriving on spilt crops, mainly potatoes.

Avocet: undergoing a Continental expansion; RSPB restoration of suitable habitat.

Black redstart: spread to England during World War II, nesting in bomb site rubble.

Firecrest: undergoing a Continent-wide expansion, mainly in coniferous woodland.

Fieldfare: Continental expansion; increase in Scandinavia creating an influx of pioneers.

Fulmar: like gulls and other seabirds, it thrives on waste from the fishing industry.

Birds in decline

Golden eagle: disturbed by increasing tourism; persecuted for lamb-killing (of which it is usually innocent); and for allegedly scaring grouse, thus spoiling a day's shooting.

Cirl bunting: harmed by trend to cooler, wetter summers and some hard winters.

Peregrine: egg collectors, falconers, chemical pesticides have all taken a toll.

Dartford warbler: loss of heathland and its reduction to isolated areas; severe winters.

Woodlark: heathland loss; post-myxomatosis scarcity of rabbit-grazed turf for feeding.

Wryneck: climate change; changing orchard practice; retrenchment in Europe as a whole.

Kentish plover: now found only as scarce vagrant, after a retrenchment in Europe.

Corncrake: mechanised harvesting of hay; earlier-growing grass; earlier harvesting.

World extinction
Greak auk: hunted for food, skins; extinct by 1844.

SEVERN WILDLIFE UNDER THREAT?

The tidal range of the River Severn is one of the highest in the world, making it one of the best estuary systems for the location of a tidal power station – a station which, if built, will profoundly affect the wildlife of the river.

Below: The Severn Estuary (and bridge) at low tide – the mudflats visible at low water are feeding areas for many wildfowl. Nobody knows just how much a barrage across the river will affect the wildlife.

The River Severn is one of the longest in the British Isles and from humble beginnings in the mountains of Wales to a graceful expiry in the Bristol Channel it absorbs 17 tributaries and embraces a great variety of wildlife habitats. The Romans called this river Sabrina, an attractive name for a waterway which, in its heyday, abounded with quicksilver salmon and seethed with elvers. The name of the river and estuary has now been corrupted to Severn, but both water and shoreline still thrive with life.

Industry along the Severn Today the lower estuary suffers from industrialisation. Water, deep and plentiful, together with a flat shoreline, are an irresistible combination to developers and the Severn has the added bonus of proximity to the South Wales coal fields. Industry has sprouted like monstrous fungi along both sides of the lower estuary and, among others, Port Talbot, Cardiff, Newport and Bristol are dependent on the waters of the Severn. But between these towns and cities and along the foreshores there are still fine sand dunes, saltmarshes, cliffs, mudflats and fens of undiminished interest. Some of the best sites are protected in nature reserves, but many remain vulnerable.

Above Avonmouth the upper estuary is less spoilt, being protected by the fierce tides

and uncertain mudflats which make navigation a skilled business. Here, apart from the docks at Sharpness and Lydney (and, most improbably, Gloucester) there are few indications of battles won against the river. The whole area is usually peaceful, a province of rural charm into which even the nuclear power stations of Oldbury and Berkeley barely intrude.

The barrage The tidal range of the Severn is one of the highest in the world: at Beachley the average is just over 12m (40ft), whereas for British tides in general it is a modest 4.5m (15ft). This makes the Severn one of the best estuary systems for the location and operation of a power station which could harness the motive force of this huge tidal surge to drive generators and thus create electricity. In an energy-hungry world such potential cannot be neglected and in 1978 the Secretary of State for Energy established a committee, under the chairmanship of Sir Hermann Bondi, to assess the feasibility of building a barrage across the river to bring the tidal flow under control.

The concept of a barrage device to convert the force of tidal flows into electrical power for the national grid is bold and deceptively simple, but the implications of such a project are profound. In particular the Bondi Committee examined the line and type of structure best suited to the Severn, methods for its construction, the various modes of operation and its projected cost and environmental impact. It is, of course, the latter–the direct and indirect effects of a barrage on the ecology of the estuary–which are the most difficult to determine.

Some practical problems Not much is known about the practicality of tidal power elsewhere in the world, and the only major scheme in operation, on the La Rance estuary in Brittany, is a minnow compared to the leviathan planned for the Severn. Therefore, in order to identify potential problems, many research projects were commissioned by the Bondi Committee; in addition the expert opinions of the Nature Conservancy Council and non-governmental bodies were sought.

It has been possible for researchers to predict certain aspects of the barrage and to some extent to model them. For example, it is generally agreed that a major effect would be the reduction of the tidal range within the estuary both above and below the structure of the barrage. This would result in the alteration of both the high and the low water levels and in the reduction of the inter-tidal banks. At present the Severn's tides expose vast mudflats which, in winter, are the feeding grounds for internationally important numbers of dunlin, ringed plover, curlew, redshank and shelduck. The precise effect of reduced feeding areas on these birds is uncertain and it is possible that there would still be an adequate food supply for them. What is clear, however, is that yet another pressure would be placed on an estuarine feeding ground–a habitat which is diminishing throughout Europe due to large-scale reclamation and flood defence works.

The report of the Bondi Committee, *Tidal Power from the Severn Estuary, Volumes I and II*, proposes a line of construction for the barrage passing from Brean Down in Avon to Lavernock Point in Wales. This is known as the 'Inner Barrage' and the Committee considered it would be the most cost-effective of the proposals studied. For, while an 'Outer Barrage', passing from Minehead to Aberthaw, would be more efficient at energy extraction, its cost and the problems associated with shipping movements into Cardiff

Above: Bewick's swans come to feed on the standing floodwaters of the Severn in winter, along with teal wigeon, mallard and tufted duck–a barrage may well necessitate the installation of pumps to drain the floodwater and hence destroy the feeding grounds of these birds.

Below: A pair of gadwall–lesser numbers of these birds visit the Severn Estuary but they, too, are under threat.

and Newport Docks make it unattractive. The lower volume of water-borne traffic which would have to bypass the Inner Barrage would not make excessive demands on a locking system.

An inherent problem associated with tidal power is that electricity production occurs in peaks determined by the tidal cycle–not necessarily corresponding with demand. Moreover, the total peaks change each day. The Bondi Committee considered a second phase–running from the Inner Barrage to Brean Down and enclosing Bridgwater Bay–which could be added to the Inner Barrage to increase its efficiency and flexibility of energy production. However, this second phase would also have the most severe implications for wildlife–especially that of the Somerset Levels and other wetlands.

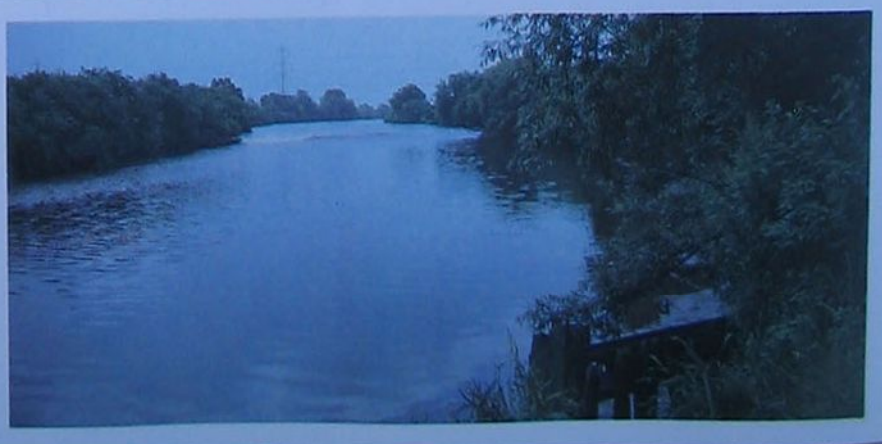
The threat to the Levels The Somerset Levels, a low-lying complex of flood-meadows, rhines and peatlands, include some of the best wetland in Britain. Traditional farming methods persist over much of the levels, and seasonal flooding determines the pace of agriculture. Here hay meadows support rich plant communities and provide breeding grounds for redshank, plover and curlew–and a haven for the otter as well.

Much of the drainage from the levels, as along the Severn generally, is by gravity, the water emptying into the river during low tide.

Above: Wild white-fronted geese in flight over the Severn Estuary. The best place to view these birds is from the Wildfowl Trust at Slimbridge. Although Slimbridge itself is unlikely to be affected by any changes consequent on the construction of the barrage, the birds that make their way there may well be disturbed by a greatly increased amount of water sporting activities that, inevitably it seems, will appear.

The Severn bore

A few miles upstream of Sharpness lies Frampton Sands, an area which, due to a geological vagary, gives rise to an extraordinary phenomenon. Here the inrushing tide, having already been constricted by the hard-rocked river banks of Sharpness, encounters sudden ledges in the river bed. The waters start to pile up and the famous Severn bore (a steep-fronted tide-wave) is born and sweeps up the river. It runs with most tides, but only occasionally does it assume dramatic proportions. The best bores occur when there is a high spring tide and the river is not in spate. The record height of the wave is over 2.7m (9ft) and on that occasion, in 1966, the standing wave travelled at 13mph. The best viewpoints are at Minsterworth on the west bank and Framilode or Stonebench on the east.



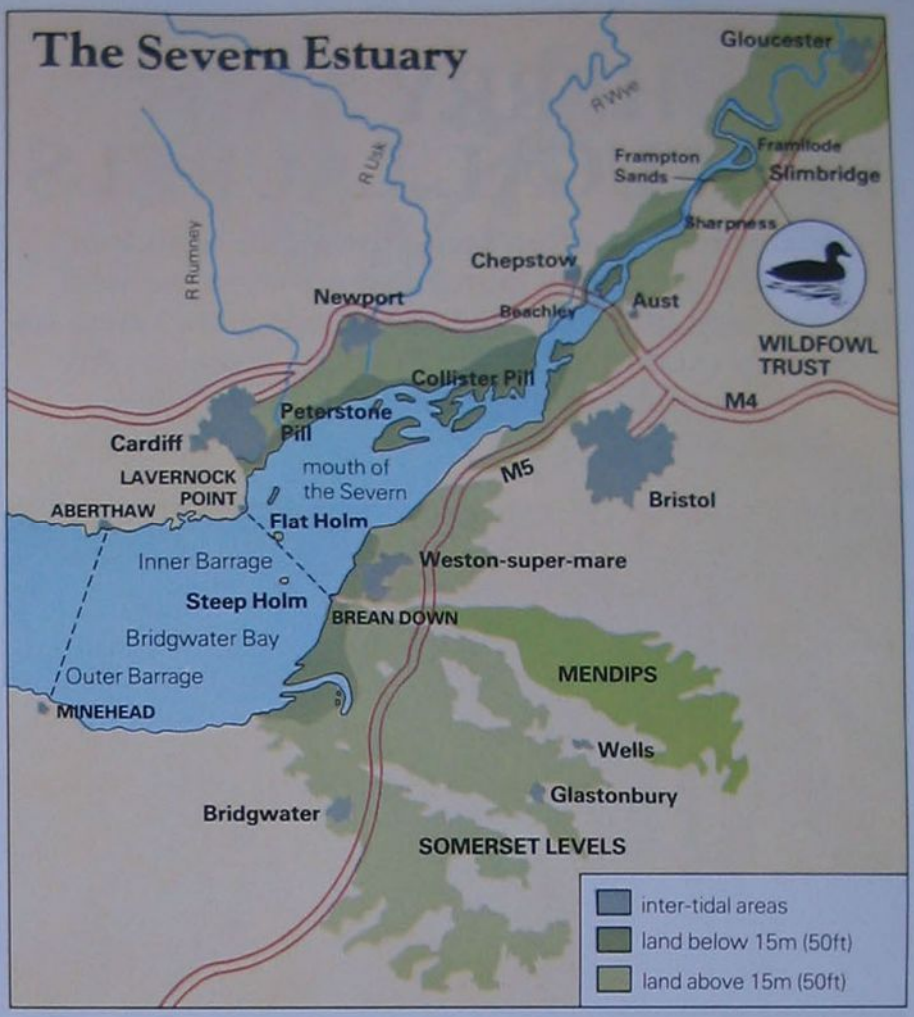
A second-stage barrage would severely disrupt the drainage pattern of the levels by reducing the discharge period. This, in turn, would tend to increase the height of the water table. Such changes would be unacceptable to farmers, who are already pressing for improved drainage. Inevitably, the outcome would be the introduction of pumping. Research submitted to the Bondi Committee concluded that the installation of pumps within the levels would result in intensified farming and the virtual destruction of the wetlands.

Bridgwater Bay is the most important of the two British moulting grounds for the shelduck. The impoundment of the Bay and severe disruption of the tidal cycle would materially alter the local environment. But such is the importance of the Bay that it is already recognised by the UK Government as the first British site ratified under the international Ramsar Agreement, which states that such areas should be protected except in the case of urgent national need. Whether a barrage could be so construed is debatable.

Even the most 'simple' scheme–an ebb-flow operated Inner Barrage–has implications for the increased drainage of the wetlands. The Wentlooge Levels of Gwent and other smaller fragments in Avon and Gloucestershire still provide a valuable wetland habitat. There is considerable pressure on these areas from 'improvers', but at present gravity drainage is limited by the high flood banks which have been installed along the river.

The very survival of these wetlands is due to the difficulty of removing flood waters which lie below the winter flood level of the river. Indeed, it is the combination of descending flood water and ascending flood tide that causes the Severn to overflow. A barrage, which would have the effect of impounding both tidal and river water, would reduce the time in which drainage outfalls could function. The solution would again be pumps, with the final destruction of marsh and other wetlands.

Threatened wildlife The wetlands in winter are precious as feeding grounds for Bewick's swans, teal, wigeon, mallard and tufted duck, while lesser numbers of pintail, gadwall, garganey and the occasional goldeneye drop in on the standing floodwaters. Geese, too, visit the Severn from the north, noisy flocks of white-fronted, greylag and Brent geese arriving in winter. The best place to view them is at another Ramsar site, Slimbridge. It is unlikely that Slimbridge would be directly affected by any of the changes so far discussed, but another possible side effect of the barrage is disturbance from water-borne recreation. At present the Upper Severn is curiously free from leisure craft, which seldom brave its turgid waters. This could change after the construction of a barrage and such recreational benefits are discussed within the Bondi report.

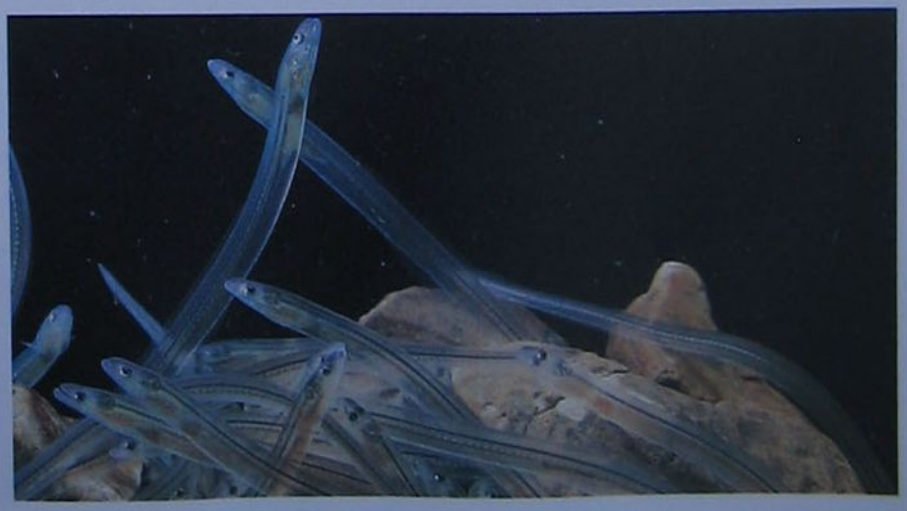


There are many other considerations. The safe passage of salmon through turbines is as yet unproven. Elvers, too, might find a barrage an impossible hazard; and considerations of changes in salinity, alterations to fish spawning grounds, the loss of saltmarsh vegetation, changing patterns of bed scouring and sedimentation must all be taken into account.

A Government decision whether to proceed with a second-phase study–at a cost of £20 million–is still awaited. Whatever the outcome, it is clear that a barrage is not a 'free' source of electrical power and that there is an environmental price to be paid.

Above: There are two possible sites for the construction of a barrage across the Severn. The 'Inner Barrage', passing from Brean Down to Lavernock Point, is considered by the Bondi Committee to be the most cost-effective. The 'Outer Barrage', crossing from Minehead to Aberthaw, would be more expensive.

Below: Elvers of the European eel–they have been fished in the Severn for centuries but may well be unable to negotiate a barrage.



CHERRY AND PORTUGAL LAURELS

Two species so often seen growing in suburban gardens, the cherry laurel also grows in the wild and has been much planted to provide game cover on country estates, while the Portugal laurel is only ever seen in cultivation in this country.

Neither the cherry laurel nor the Portugal laurel are true laurels, despite their names. True laurels are members of the laurel family, of which the sweet bay (*Laurus nobilis*), from which we get our bay leaves, is the most familiar. The cherry and Portugal laurels, on the other hand, are included among the cherries because of their five-petalled flowers and their dark purple, cherry-like fruits. But the fact that they are both shrubby and have oval evergreen leaves somewhat similar to those of the sweet bay led to their being called laurels, as indeed were several other broad-leaved evergreen shrubs.

Cherry laurel This species is one of our most familiar broad-leaved evergreens. It is

native to forests bordering the southern part of the Caspian Sea in Iran, where it is often seen growing in association with the oriental beech. It is also found in the Caucasus mountains of the USSR, the mountains of central Turkey and west into the European part of Turkey and Bulgaria. There is also an isolated population in Yugoslavia.

The cherry laurel has been cultivated in southern and western Europe for centuries, certainly since the 16th and 17th centuries, and is now naturalised in many of these countries, including Britain and Ireland.

In Britain, the cherry laurel is most commonly seen as a widely branching shrub between 1.5m (5ft) and 3m (10ft) tall. The leaves are arranged alternately and are large (up to 20cm/8in long) and thick with minutely toothed or entire margins.

The flowers of cherry laurel are similar to those of other species of cherry, each flower having five separate petals and a cluster of protruding stamens. Usually produced in April, the creamy-white flowers are up to 8mm across and strongly (though not pleasantly) scented. The flowers are borne on elongated heads called racemes, like the flowers on the closely related bird cherry.

As the fruits of the cherry laurel begin to develop, the similarity between it and other species of cherry is again apparent. Each fruit is globose (ie, globe-shaped) and up to 1.5cm (§in) across, turning from green to red and becoming blackish-purple around September. Like an ordinary cherry, the fruit has an outer fleshy layer and a central stone; it closely resembles a small sloe but you cannot eat it for it is poisonous.

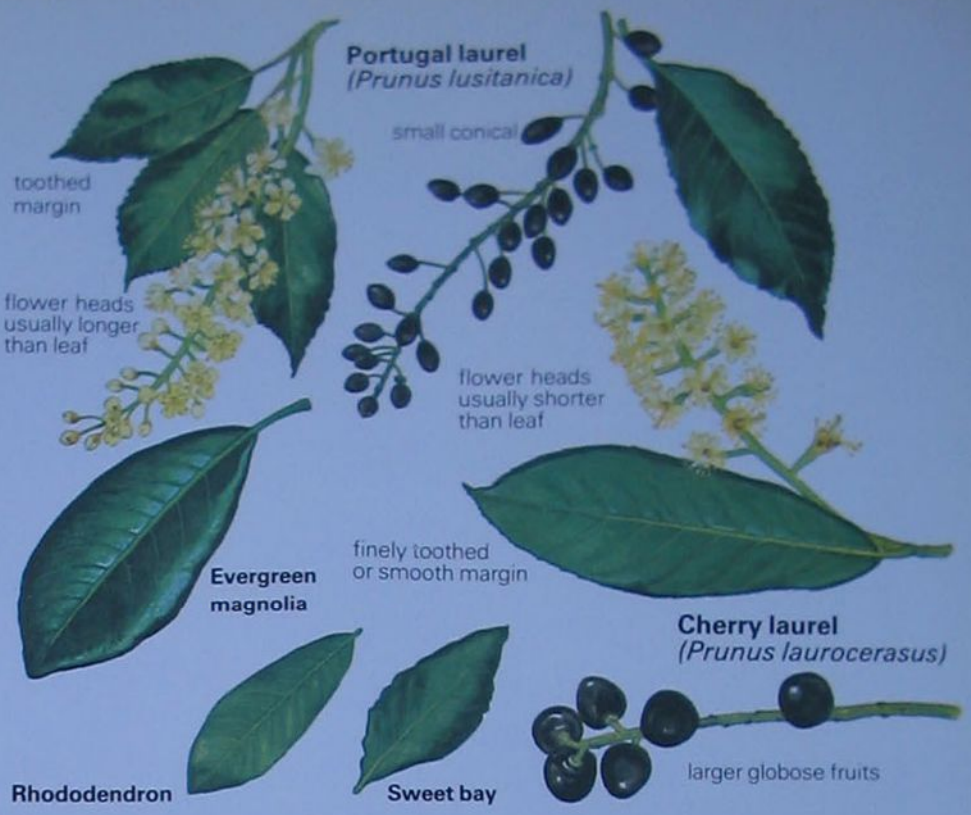
The Portugal laurel This species was introduced to Britain in the middle of the 17th century. It is native to Portugal and Spain, its range just extending into south-western France. The Portugal laurel also occurs on the islands of the western Atlantic, most notably in the famous evergreen forests in the mountains of the Canary Islands. It also occurs in the Azores, where it is distinguished as a separate sub-species because plants from there have relatively wider leaves, shorter racemes with fewer flowers and shorter fruit-stalks. The sub-species was introduced to Britain in 1860 and is sometimes cultivated here.

The Portugal laurel is generally taller than the cherry laurel, sometimes growing to become a small tree. It is usually between 3m (10ft) and 6m (20ft) high, though it may reach a height of 15m (50ft). It has smaller leaves (up to 13cm/5in long), the margins of which are more conspicuously toothed.

In flower, the two species are easily distinguished, particularly as the Portugal laurel usually flowers in June, which is two months after the cherry laurel. Instead of the cherry laurel's short upright heads bearing some 30 flowers, the Portugal laurel has a profusion of spreading or pendulous elongated heads, each with up to 100 flowers. These have a scent that has been likened to that of the hawthorn. The inflorescence of a Portugal laurel is usually much longer than the leaf from which it arises, whereas on the cherry laurel the inflorescence is usually shorter than the leaf.

The fruits of the Portugal laurel are similar to those of the cherry laurel, though slightly smaller and more conical. They ripen through red to a dark purple.

Wild and cultivated Of the two species, only the cherry laurel is naturalised in Britain. Since it occurs as an understorey to beech in its native lands, it is not surprising that cherry laurel grows quite happily in the shade in this country. Indeed, it is one of the most useful



Above: Leaves, flowers and fruits of the cherry and Portugal laurels, with the leaves of other common evergreen shrubs for comparison.

Opposite page: Usually seen as a shrub, cherry laurel is sometimes encountered as a tree, as in this large specimen with its twisted and much fluted trunk.

Below: Cherry laurels flower in April, bearing upright racemes of creamy-white flowers.

evergreens for such situations and is planted to provide protection for gamebirds in coverts. The spreading lower branches give the birds shelter from the wind, rain and snow, and the berries supply food at a time of scarcity. The seeds from these woodland plants germinate readily and have allowed the cherry laurel to become naturalised in this country.

In cultivation, the cherry laurel is probably seen at its best when it is grown on its own in the lightest shade, with plenty of room for it to expand. The tallest garden specimens are to be found in the west of Britain, where the damper climate allows specimens to form trees some 8m (27ft) tall, though exceptional plants of 14m (47ft) tall have been recorded.

On lime-rich soils, the cherry laurel does not fare so well, its leaves tending to become yellow and fall off, and under these circumstances the Portugal laurel is the more appropriate species to plant. Both species are generally hardy in Britain, the Portugal laurel slightly more so.

Above: The Portugal laurel flowers in June, two months after the cherry laurel. The individual flowers are similar in the two species but on the Portugal laurel many more are borne on the flower heads, which tend to spread out horizontally or even hang down.

Right: Of the many cultivars of cherry laurel, one of the best known and most suitable for small gardens is 'Otto Luyken', a low-growing shrub, seen here in full flower.

Below: Berries of the cherry laurel, ripening from green through red to become dark purple at maturity. Portugal laurel berries are similar, though smaller and more conical.

Killing jars Back in the days when budding young naturalists were taught that before nature's diversity could be appreciated it must first be killed and preserved, every schoolboy knew that a few crushed cherry laurel leaves in a jam jar made an excellent 'killing jar' for butterflies: the insects remained relaxed long enough for the wings to be spread out and set.

This property arises from the fact that all parts of the plant, but particularly the leaves and fruits, are poisonous because they contain hydrocyanic (prussic) acid. In spite of this, a distillation (presumably weak) of the young leaves was once used to treat respiratory disorders and dyspepsia.

DISAPPEARING WOODLAND LICHENS

With as many as 200 different species of lichens to be found in a square mile, woodland is one of our richest habitats for these strange partnerships of alga and fungus. Many, however, are threatened by forest management and air pollution.

Above: The most common substrate for woodland lichens is the trunks and branches of trees, but it is important not to ignore other habitats. Dead tree stumps, for example, are likely homes for certain lichens, such as species of *Cladonia*. Woodland banks may also support a few species of *Cladonia*, while in grassy ridings the lobes of *Peltigera* are sometimes conspicuous among the herbage, especially on poor-quality acid or calcareous soils.

A lichen is composed of a fungus and an alga forming a close symbiotic relationship. The alga produces the green pigment chlorophyll, which manufactures carbohydrates, these being absorbed by the fungus and utilised for its growth. The fungus, in turn, protects the alga from drought, allowing it to grow in places that it would otherwise find too dry and inhospitable.

Unlike the higher plants, lichens do not need to absorb water and salts from the soil, and unlike true fungi they do not need to live as parasites or saprophytes to obtain their nourishment. Free of such constraints, they are able to colonize such habitats as the bark of trees, using these 'hosts' merely as anchorages. Their mode of life is called epiphytic.

Lichens can be extremely prolific in woodland. The bark of a tree is a habitat for which a lichen usually faces little competition from other plants, and the area of bark to be found in a wood is huge. This, plus the fact that different species of lichen tend to live on different parts of a tree and on trees of different ages, explains why there can be as many as 200 species of lichen in a square mile of woodland.

Lichens and age The species of lichen inhabiting a tree vary with its age. When a tree is young and its bark smooth, the first lichens to colonize it are the crustose species. The letter lichen *Graphis* is a typical pioneer on shaded smooth bark in woodland, its fruiting bodies (which produce the spores) forming undulating black lines over the surface of the bark.

As the tree gets older, the bark becomes colonized by foliose and fruticose lichens, forming a second layer over the crustaceous lichens. (Foliose lichens have leaf-like structures, while the fruticose species bear strap- or finger-like branches.) A foliose species commonly found in woodlands in southern England is *Parmelia caperata*. This attractive lichen forms large pale greenish-yellow rosettes and frequently dominates the boles of mature trees. One of the more common fruticose lichen on mature trees is the oak moss (*Evernia prunastri*). This produces hang-

ing, antler-shaped plant-bodies which are whitish-grey on the upper surface and whitish on the undersides.

When the tree dies, the bark decays and the lichens on them are killed. However, as the dead bark falls off, certain specialised lichens begin to colonize the acid surface of the exposed wood beneath. These lichens are mostly small crustose species, such as *Hypocenomyce scalaris*, which forms small greenish overlapping scales.

Trunks and branches As well as changing with the age of the tree, the lichen flora also varies from one part of a tree to another. The base of a tree is frequently occupied by *Cladonia conicraea*. This species consists of grey-green scales, from which arise slender hollow stalks.

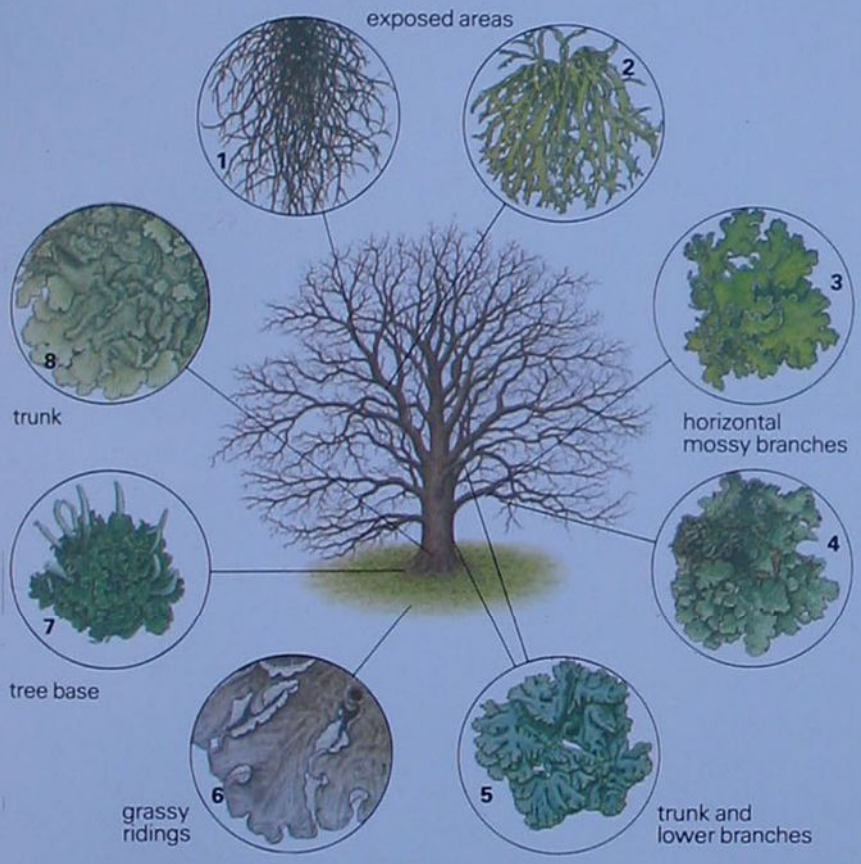
Old horizontal mossy branches support such leafy lichens as *Cetraria chlorophylla* with its deeply lobed olive-coloured 'leaves'. Towards the ends of thinner branches are the crustose lichens, while in exposed areas festoons of strap-like *Ramalina* species, beard moss (*Usnea* species) and *Bryoria fuscescens* are all frequent. This latter group of species are all fruticose lichens.

Unlike true fungi, lichens are not restricted to a particular species of tree. However, some trees are more favoured than others. Far more lichens have been recorded on oak in the British Isles than on any other tree – 303 species all told. Ash also has a varied lichen flora and is the second richest tree with 230 species. It has the advantage of a bark that is neither acidic nor alkaline and is, therefore, particularly favourable for colonization. On the other hand, trees with very acidic barks, such as the birch and the conifers, tend to have a limited lichen population in lowland Britain.

Lichens and tree management The replacement of our native hardwoods with plantations of alien softwoods has been a major feature of British forestry in recent decades. Because conifer bark is generally so inhospitable to lichens, this has had severe implications for our lichen population and is inevitably leading to a significant loss of woodland species in many areas.

Right: *Usnea ceratina*, one of several species of woodland beard moss, here seen growing on an oak tree. Beard moss grows on the more exposed parts of a tree, as do some other species of fruticose lichens. It seems that, in general, the growing habit of fruticose lichens in which they branch from a single point makes them better suited to withstand windy exposed conditions than either the foliose or the crustose lichens.

Lichens on oak



Different parts of a tree are likely to harbour different species of lichen. Shown here are some typical lichens that might be found on various parts of an oak tree or in its immediate vicinity.

1 *Bryoria fuscescens* A fruticose species producing hair-like branches 15-20cm (6-8in) long.

2 *Ramalina farinacea* Greenish-grey fruticose lichen that hangs in tufts from the branches of trees.

3 *Cetraria chlorophylla* Foliose lichen that forms brownish-green, deeply lobed tufts with pale undersides.

4 *Platismatia glauca* Similar to (**3**) except that its tufts are usually greyish-blue above and dark brown beneath.

5 *Hypogymnia physodes* A foliose lichen with pale grey tufts; very common throughout Britain.

6 *Peltigera* spp. Foliose lichens usually less than 10cm (4in) across and varying in colour from pale grey to greenish-brown.

7 *Cladonia conicraea* Foliose lichen consisting of grey-green scales and slender stalks.

8 *Parmelia caperata* Foliose yellow-green lichen found in patches up to 20cm (8in) across.

It is not only modern changes in forestry that are having a profound effect on our lichens. Lichens are long-lived and extremely slow-growing, which means that our present flora has been greatly influenced by woodland practices in the past. For example, many of the woods in eastern England have been extensively managed from Norman times until the present century. In most of these, there has been no continuous succession of old trees, for in medieval times the dominant woodland species, the oak, was felled before reaching maturity. Therefore lichens that depend on old trees as a habitat were eliminated many centuries ago.

Rich wood-pasture The richest woodland for lichens is that associated with wood-pasture. This is woodland that has long been used by man for grazing his animals and hunting. Royal hunting forests and chases, and parkland and commons with a substantial tree population, all count as wood-pasture. From the point of view of lichens, the most outstanding example of wood-pasture is the New Forest with 259 different species having been recorded there.

Because lichens vary so much with the history of a woodland, they can be used as biological indicators of old wood-pasture. The most significant indicator of this kind is the tree lungwort (*Lobaria pulmonaria*), a large and spectacular foliose lichen that was probably dominant on trees throughout the British Isles during the Atlantic period (between 7000 and 4000 years ago). It has been reduced to its present scattered distribution by man's management of woodland and, in areas where it still exists, it indicates that mature trees have been growing there throughout historical times.

Another relict lichen of wood-pasture is *Thelotrema lepadinum*, which forms a pale greyish, shiny crust on barks. It is the only old wood-pasture lichen still surviving in the extensive Rockingham Forest in Northamptonshire. It is believed that most of the original woodland in the forest had been cleared by Roman times, the present forest dating back largely to the Saxons. Therefore, many lichens were probably already extinct in the forest some 2000 years ago. The final death-blow to the lichens came in 1932, when the steel-town of Corby was established. The smelting of iron caused widespread air pollution which destroyed much of the remaining lichen.

Above: Tree lungwort being browsed upon by a pair of woodland snails. The truncated lobes and depressions in the surface are typical of this species of foliose lichen. It used to be common throughout the British Isles but is now frequent only in the western, more pollution-free parts of the country.

Right: One of the first lichens to colonize a young tree is the letter lichen. It forms a thin greyish crust over the bark, interspersed with undulating black lines which are the lichen's spore-producing bodies.

Below: The oak moss is a common fruticose lichen on mature trees, forming hanging tufts up to 6cm (2½in) long. Its branching thalli resemble antlers and are greenish-grey on the upper surface and whitish beneath. This species is collected on the Continent for use in perfumery.

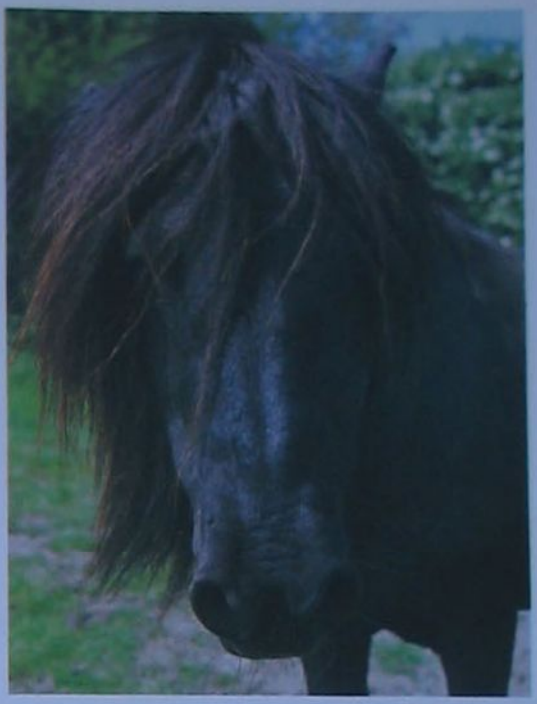
Pollution problems Air pollution has perhaps had as great an impact on woodland lichens as forest management. For example, many of the more pollution-sensitive lichens, such as beard moss, have become virtually extinct in the Midlands and eastern England, our most polluted regions.

Not all lichens are sensitive, however, and one species has benefited from the spread of pollution. This is *Lecanora conizaeoides*. It was unknown in England before about 1860 but spread rapidly with the impact of the Industrial Revolution, so that today it is one of our most common lichens. It forms a monotonous grey-green powdery coating over tree bark and can be found in most woodlands in lowland Britain.

Fortunately, action is slowly being taken to combat air pollution but, if we are serious about conserving our woodland lichens, something must be done about the threat to our old deciduous woodland, especially from the continuing establishment of conifer plantations. Perhaps the answer is to subject our forests to the kind of planning controls now used to protect our historic buildings.

SHETLAND PONIES: STRENGTH FOR SIZE

Of all our native pony breeds, the Shetland is probably the best known and loved. Its unique small size, short legs and sturdy body, together with its bushy mane, forelock and tail, make it instantly recognisable, even to the least 'horsey' person.



Right: There is a belief, dating back to the early 19th century at least, that black Shetland ponies are the hardiest.

Opposite page: Shetlands in winter. Although the most common colour is black, there are also browns, some chestnuts and a few greys. There are also a considerable number of skewbalds (brown and white) and a few piebalds (black and white). The Shetland Pony Stud Book Society is the only native pony society that will register 'odd-coloured' ponies.

Below: A Shetland pony far from its treeless native habitat. This breed is popular all over the world.

Shetland ponies, frequently featured in cartoons, have appeared in circuses and pantomimes, taken countless thousands of children for rides at zoos, and have been ridden and driven by royalty, all of which may suggest that these attractive animals are pampered pets. However, in the harsh environment of their native Shetland Isles, nothing could be further from the truth. Possibly no other native breed has had to withstand such rigorous conditions, nor is better equipped to do so. And far from being pets, Shetland ponies in the past were the only means of transport for the islanders and their goods.

Although the Shetland Islands are about 100 miles north of mainland Britain, their climate in terms of temperature alone is not as harsh as might be expected because of warm ocean currents. Prolonged and heavy snowfalls cause deep drifts but do not normally lie for long. For the ponies the most trying conditions are the frequent gale-force winds which drive rain and sleet across the treeless landscape.

Special adaptations The ponies are well-adapted to cope with these bleak conditions and the lack of good grazing. Their small size, believed to be the result of their long isolation in an environment providing limited food and shelter, is clearly an advantage: a small pony needs less food, can shelter behind rocks and boulders that would be inadequate for a larger animal, and has less surface area from which to lose heat.

The Shetland's size is of special interest, too, in that it is the smallest of the native British breeds; its height is officially measured in inches, not in hands. It is sometimes claimed that if the ponies were bred in a kinder climate they would soon grow in height, but this is not the case. Pure Shetland ponies, whether they are bred in Shetland or Australia, remain small although, as with any breed, it is always possible that if ponies of the maximum height are mated their progeny may be marginally over the maximum.

In addition to its small size, specific anatomical features of the breed are also excellent adaptations to the environment. The head is neat and relatively small, but not too small–a characteristic often sought in show specimens which do not have to cope with extremes of weather–because this would not allow for a sufficiently large nasal cavity.

The nasal cavity is large enough to allow space for the cold air to be warmed before it passes into the lungs. The deep chest and abdomen give plenty of space for large lungs and intestines. Ponies living on their native heath are inclined to appear permanently in foal. Although this swelling of the abdomen can, of course, be due to pregnancy in mares, it is partly the result of the fibrous nature of the food. Moorland grasses and heather are of relatively low nutritive value and so the ponies must consume more than if they were grazing lush grass. They spend much longer each day grazing than do ponies on better pasture.

The winter coat Possibly the most highly adapted feature of Shetland ponies is the nature and function of the winter coat. As in all native horses of the northern hemisphere, the Shetland begins to grow a winter coat in September. It consists of two different layers: a fine undercoat, and a coarser, tougher outer layer of hairs that are long enough to cover the undercoat. Greasy flakes among the undercoat are believed to help trap air and so provide additional insulation. The double coat not only keeps the pony warm but is specially constructed to keep it dry: a pony that is wet to the skin is in great danger from heat loss.

The function of the coat is probably best seen when the animal is wet. The longer outer hairs form numerous triangular-shaped groups, with the apex of the triangle pointing downwards. The rain and melting snow move down over the greasy surface of the coat, collect at the apex in drops, and finally run off the animal's body without penetrating the fine undercoat. The hairs grow so that the moisture is directed away from the less well protected regions such as the dock and the under surface of the body.

Native diet The ponies eat mainly moorland grasses in their native surroundings, and heather if they are very hungry. During winter, if they cannot reach any herbage by scraping the snow away with their forefeet, the crofters hand-feed them with hay or a sheaf of oats. Ponies with access to the shore take seaweed, especially in winter. Seaweeds contain trace elements which are valuable in an otherwise poor and acid-based environment. It seems that ponies which feed on seaweed regularly have better bones than their relatives who cannot. Some owners move their animals from one holding to another where the shore is accessible, so that they may benefit from the seaweed.

Life today On the Shetlands the ponies live a life that is not so far removed from the wild, although they are all privately owned. The mares are turned out on the common grazings or 'scattalds' for most of the year, but they are usually brought in to the 'in-bye' land near the crofts for winter or if there is a heavy snowfall. The stallions are only turned out for the breeding season. They have been specially selected by the Shetland Pony Stud Book Society to improve the breed. Each collects some 30 or so mares around him, and he herds them in the usual way during the months he is on the scattald.

Above, below: Shetland ponies at Unst. In spite of their diminutive size, they are enormously strong. In proportion to their body weight, they can pull far greater loads than many other horse breeds. However, the Shetlands were not primarily draught animals but pack and riding ponies. All but the smallest can carry a full-grown man.

Opposite right: Looking north from Fitful Head in the Shetland Isles, home of the ponies.

SHETLAND PONIES
Size Not exceeding 102cm (40in) at 3 years of age; not exceeding 107cm (42in) at 4 years of age and over.
Colour Any, including a considerable number of skewbalds (brown and white) and some piebald (black and white). Exceptionally bushy mane, forelock and tail.
Breeding season Between May and August.
Gestation Approximately 11 months.
Number of young Normally one.
Lifespan 20-30 years.
Food Coarse grasses, ling and heather.
Distribution The Shetland Islands, and throughout Britain on private studs.
Breed Society Shetland Pony Stud Book Society.
Where to see Shetlands On the Islands; at horse, pony and agricultural shows throughout Britain.

Each herd has its own territory, often near the croft, but the ponies may wander anything from five to twenty miles or more. Once the stallions have been taken off after the breeding season, adjacent herds mix–in contrast to New Forest ponies which retain their herd structure over the years.

Mares find a secluded spot when they are due to foal, usually near the herd. Most mares foal without help quite easily, especially if they are not too fat. Occasionally there are problems and stallions have helped with the foal. Sometimes the mare is too weak to stand and help the new-born foal to struggle clear of the tough bag (amnion) in which it is enveloped at birth. A stallion has been known to bite through the bag and release the foal. Shetland mares produce remarkable quantities of milk, a characteristic shared with other Shetland mammals.

Park and pet ponies Although Shetlands are now used largely for pleasure and are excellent first ponies for children, they were once a vital part of the Shetland economy. They carried enormous packs, from men to loads of peat. Special pack saddles were fitted. There is evidence that they have been used in the service of man for 2000 years or more, as bones roughly the size of the modern pony have been found in Bronze Age settlements on the islands. No fossils of ponies have been found, so there is no certain knowledge of how long they have been there. It is thought that the present-day animals are descended from Tundra ponies, probably from Scandinavia, which arrived possibly as long ago as 8000 BC. These were joined by smaller mountain ponies from the Iberian peninsula, and smaller ponies brought by the Celts; in due course crosses between them produced the Shetland, but exactly how is to some extent speculative.

The sturdy little Shetland pony

A close examination of the coat of a Shetland pony shows that there are areas where the hair grows in whorls or vortices. The most obvious, and perhaps the most important, is the one that lies on the flank just below the point of the hip. The hair in the upper part of the whorl fans upwards and turns either forwards or backwards to join the streams of hair on the remainder of the body which carry the rain away from the thigh. This prevents water reaching the inner unprotected surface of the thigh and the inguinal region. It has been found that if the vortices are not in the correct position the pony is much more liable to lose condition and to suffer, or even die, in severe weather. In a similar fashion the vortex over the dock channels rain away from the area; this is often assisted by a tail that is 'low-set' (not a desirable feature in a show pony). The downward curvature of the tail vertebrae and tail also gives protection.

small neat head
just below point of hip, hairs grow in a whorl (vortex) fanning upwards and outwards to channel rain away from thigh
flank
vortex over tail channels rain away
bushy mane, forelock and tail
winter coat has two layers: a fine undercoat and tougher outercoat
sturdy body
short legs

Left: Since flowers can be few and far between on the poor mountainous terrain where the scotch argus (*Erebia aethiops*) is found, the adults feed on a wide variety of plants—this butterfly is drinking nectar from a bramble flower. The caterpillars are more particular, however, feeding entirely on purple moor-grass, a plant which grows abundantly on mountain slopes in Scotland.

THREE MOUNTAIN BUTTERFLIES

The mountainous regions of Britain—barren and inhospitable tracts of land—are the home of three attractive species of butterflies: the mountain ringlet (renowned for the effective way it protects itself from hungry predators at all times), the scotch argus and the large heath.

The mountains of Europe, endowed with rich alpine meadows, support a wide variety of plants and insects—a claim we cannot make in Britain, since the chief characteristic of our uplands is poor quality grassland and bogs. Nevertheless three species of British butterflies do manage to thrive in these bleak and inhospitable conditions. They are the scotch argus, the mountain ringlet and the large heath. All are 'brown' butterflies, members of the family Satyridae, and are only found in northern Britain.

Scotland's mountain butterfly As its name implies, the scotch argus is found throughout Scotland, although it also occurs in a few scattered localities in northern England. Within Scotland its distribution is closely related to the mountains, where it is often found on marshy hillsides. Here the adults can sometimes be seen flying in the sunshine, but at other times they remain deep down in the grassy tussocks.

From a distance these dark brown butterflies appear rather drab, but a closer look reveals their rich deep velvety-brown colour, shot with reds and purples, which contrasts with rust-red marginal bands with prominent black and white eye-spots. These bands are particularly conspicuous on the paler females.

The female lays her relatively large eggs singly on the larval food-plant—purple moor-grass. In common with all the 'browns', the

The mountain ringlet's extra 'eyes'

The eye-spots are arranged on the wings so that the attention of birds is always deflected away from the vulnerable body.

a)

When in flight—and therefore exposed to predators—the eye-spots on the upper wing surfaces are conspicuous.

b)

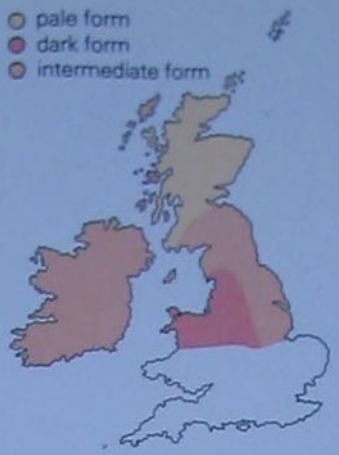
On landing (a) the upper wing surfaces are briefly displayed. The wings are then closed (b) to reveal the under-forewing spots.

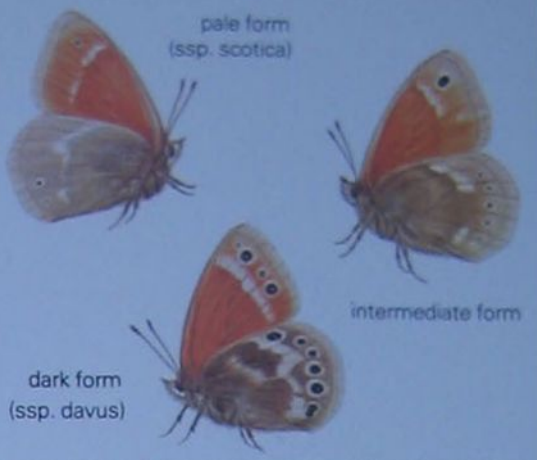
c)

If unmolested after a further few seconds, the forewings are folded inside the hindwings (c) to leave a camouflaged exterior.

Colour variation – north to south

The large heath butterfly varies in wing colouring according to where it lives – a phenomenon known as 'clinal variation'. The butterflies from most of Scotland are poorly marked and pale, those from the Scottish borders, northern England, the Western Isles and Ireland are slightly darker with more eye-spots, while specimens from Lancashire and Wales are heavily spotted and the darkest. The causes of this are uncertain, but it may be a response to climate and 'predation pressure' – the higher altitude butterflies with less spots are exposed to fewer insectivorous birds.





caterpillars are shades of green or light brown with pale longitudinal stripes. They feed during the summer nights, and then crawl deep down into the turf in October to hibernate for the long harsh winter.

On waking up the following spring, they resume feeding and are fully grown in July, when they form chrysalids in loose cocoons on the ground. The adults finally emerge in late July and can be seen flying around in sunny weather until late September.

Solo alpine species The small mountain ringlet is our only true alpine butterfly since it is rarely found below 550m (1800ft), and is restricted to the mountains of Cumbria, Argyll, Inverness and Perth. Despite inhabiting some of the wettest places in Britain, with more than 5100mm (200in) annual rainfall, this species is a sun-loving butterfly, and flies only when the sun is out. It is therefore remarkable that the butterflies manage to proliferate when cold mists may shroud the hillsides for weeks during their mating season.

Adult mountain ringlets are a rich deep brown colour, appearing almost black when freshly emerged from the pupae. Their dark colouring maximises heat absorption when they bask in the sun – a process necessary to raise their body temperature and enable them to become active.

During these fleeting sunny spells, the adults channel their energies into finding a mate and laying eggs. The males avidly seek out females, flying low over the turf to avoid being blown away from the colony site by strong winds. The eggs, which the females lay on mat grass, are large to provide the young caterpillars with sufficient food reserves when they hatch into the hostile environment. Like the caterpillars of the scotch argus, they feed during the summer and then hibernate from the end of August until the following March, eventually completing their development by June.

Right: The large heath butterfly (*Coenonympha tullia*) is found on damp boggy moorland. Sadly its numbers are dwindling in England as a result of land reclamation and drainage schemes – in the past it occurred as far south as Derbyshire, but nowadays it is found in only a few localities in Cumbria, Northumberland and Yorkshire. The contrary has happened in Scotland, however, where the spread of blanket bogs has actually strengthened its population. It also has a wide distribution in Ireland, and occurs in a few sites in North Wales.

Below: Despite inhabiting some of the wettest parts of Britain, the small mountain ringlet (*Erebia epiphron*) is a sun-loving species, flying only in bright sunshine. A cloud only has to pass across the sun to make this butterfly disappear.

Bog butterfly The final species associated with upland Britain is the large heath butterfly. While it has been recorded as high as 760m (2500ft), it is generally found at all altitudes on wet ground. A characteristic plant of this terrain – cottongrass – is thought to be the foodplant of the large heath caterpillars.

Like the other two mountain species, the caterpillars hibernate over the winter and take one year to complete their life-cycle. The adults appear any time from June to August, depending on how far north or south the population is.

TURNSTONE AND PURPLE SANDPIPER

Our wintering waders are generally seen on mudflats and estuaries, except for two: the turnstone, which visits rocky shores as well as beaches and nearby fields; and the purple sandpiper, which is a true specialist of the rocky shore. The two species can be seen together in mixed flocks.

Above: A mixed flock flies along the strandline between feeding grounds. About a third of them are purple sandpipers and two thirds are turnstones. The purple sandpipers are slightly smaller, dark birds with long, down-curved bills. The turnstones can be identified by a white stripe along the back and an extra wing stripe, which shows as a clear white area, often L-shaped, almost on the shoulder.

Those of us who brave winter weather to walk around muddy shores are probably familiar with the most noticeable features of a typical wader–a long bill for probing into the mud for hidden food, and long legs to permit the bird to walk in the shallow water among breaking waves without getting its belly feathers too wet. It is somewhat surprising, therefore, to discover that these features are little used for these purposes on the breeding grounds, for most waders breed during the short summer of the high Arctic, where their staple diet consists of the myriads of midges and their larvae abounding on the tundra.

Two of the waders that visit our coasts in winter have tended to forsake the mud and manage, instead, to eke out a living from our rocky shores. These are the purple sandpiper and the turnstone. Like other waders, they breed in the Arctic, except that in some recent years perhaps one single pair of purple sandpipers has bred in an unpublicised locality in Scotland. For all practical purposes, therefore, the two species are migrants visiting Britain and Ireland for the winter months only.

The purple sandpiper This species is almost entirely restricted to rocky shores during its stay in Britain and Ireland. It is a stocky bird, about 20cm (8in) long, and is usually found feeding in small flocks. The head and breast are sooty brown, while the back is a little

Purple sandpiper (*Calidris maritima*). Winter visitor to rocky shores all round Britain and Ireland. Though classed as a wader it is very much a rocky shore specialist. Sexes are alike. Length 20cm (8in).

Turnstone (*Arenaria interpres*). Winter visitor to rocky, sandy and muddy shores round Britain and Ireland. Frequently lifts stones to find prey. Sexes are alike. Length 23cm (9in).

Right: A turnstone in full summer plumage. You can see varying degrees of summer plumage on turnstones in Britain and Ireland, for in spring some of them begin their seasonal moult before departing for the breeding grounds; and in autumn some arrive with their breeding plumage still showing. However, such birds are in the minority and it is commoner for turnstones in Britain and Ireland to be seen in complete winter plumage. Purple sandpipers, too, are sometimes seen in summer plumage, but this is normally only in spring, for in autumn they almost all arrive in winter plumage.

darker, at close range showing a purplish tinge. The eye is surrounded by a fine white ring. The throat, belly and under-tail are white, and in flight the upper wing shows a white wing bar.

In addition to being stocky, the purple sandpiper also appears somewhat squat, for its legs are a little shorter than many of its mud-dwelling relatives. A useful identification feature is that the legs are yellow, as is the base of the slightly down-curved bill.

As the birds develop their breeding plumage, brownish feather edgings on the back give them a more mottled appearance. Sometimes this occurs before they migrate northwards in spring, so that you can see purple sandpipers that look lighter than usual while they are still on our shores.

Below: A purple sandpiper resting on a shingle beach. This bird is clearly in winter plumage, looking dark with a slight purple tinge. The shingle is a good place for roosting after tirelessly hunting for food amid the harassment of the waves.

The turnstone Squatness and stockiness are features the purple sandpiper shares with the turnstone, but the latter is a little larger, being around 23cm (9in) long, and with much more boldly marked plumage. In winter the back and breast are dark grey-brown, and while the head is the same general colour it has suggestions of white markings behind the eye and on the cheeks. The throat and belly are white, the latter being separated from the dark breast by a clearly defined line. The contrast between the dark breast and the white throat and belly gives the appearance of a distinct, dark breast band.

In flight, even a winter plumage turnstone is readily distinguished from the purple sandpiper, for it is much more strongly patterned, with a double white wing bar and broad black and white bars on the rump and tail. The turnstone's legs are generally orange and its pointed bill is black.

In summer, the turnstone takes on a completely new appearance, to become one of our most striking shorebirds. The head and breast become strongly patterned in black and white, and the back develops rich chestnut patches, giving a 'tortoiseshell' look. While

you are most likely to see winter plumage birds in Britain or Ireland, in the spring and autumn you can find turnstones in all stages between winter and summer.

Arctic migrants To breed in the Arctic imposes considerable restrictions on the breeding season of shorebirds, for they cannot begin their reproductive activities until the snow and ice have thawed, and they must depart before freezing conditions return. The breeding season is thus necessarily short, and most of their life is spent in warmer climes.

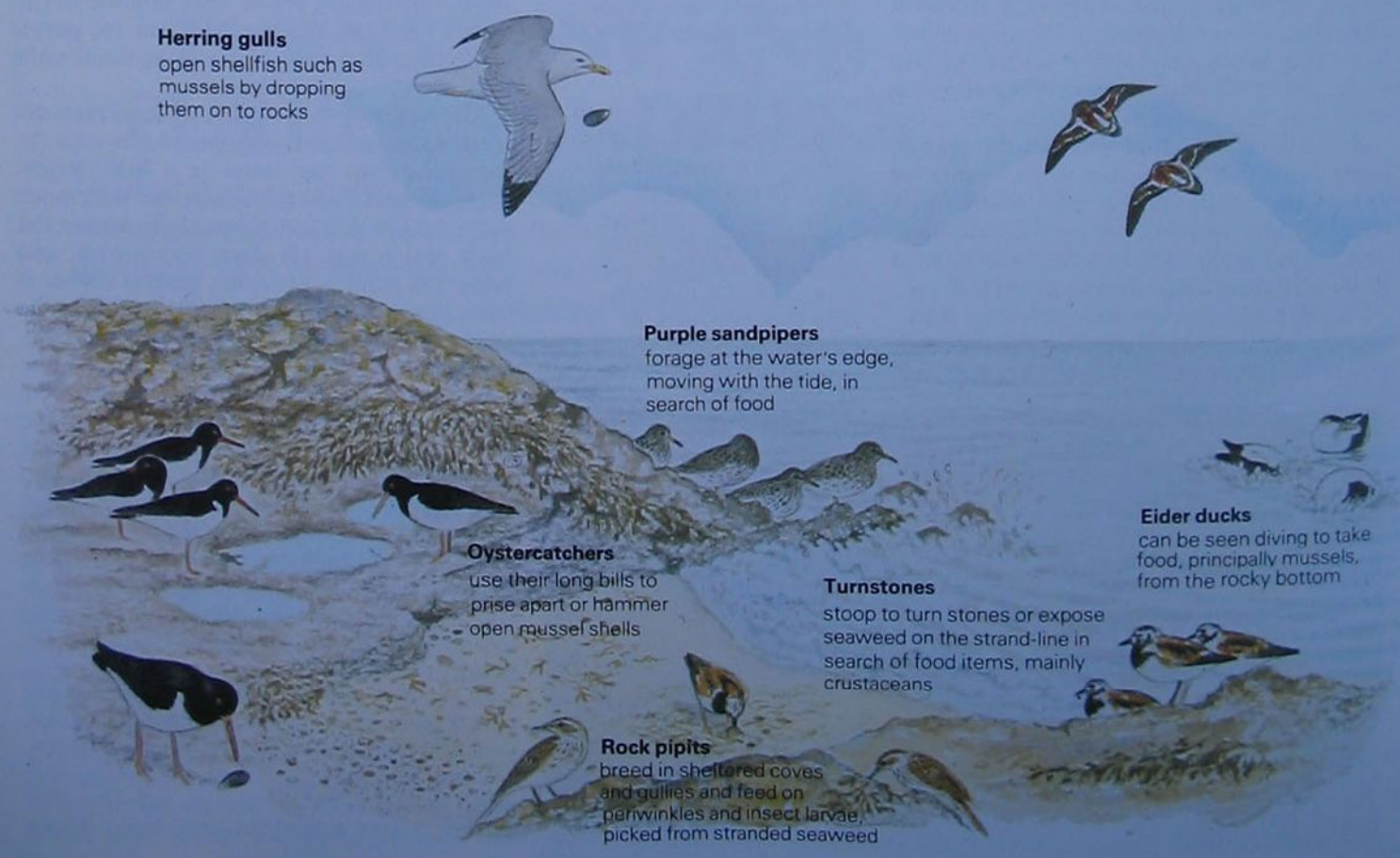
The purple sandpiper has a comparatively short migration for a shorebird, going little further south than the British Isles. Ringing has shown that the birds wintering on our coasts, mainly on the flatter rocky coasts of the north and east, breed mainly in Norway, although a few come from Iceland. It has been estimated that somewhere around 20,000 purple sandpipers winter on British and Irish shores.

Above: A purple sandpiper attempts to feed at the shore of a lake. The commonest cause for these birds to leave the rocky seashore is when high tides cover it for too much of the day. This happens in the Scottish winter, with its short daylight period. The birds then feed either on the rocks and strandline at night, or in grassland and fresh water habitats during daylight hours.

Although many turnstones winter around the coasts of the British Isles, the proportion spending the winter at such northern latitudes may well be small compared with that which passes on beyond Britain to winter on the shores of tropical Africa and even further south. Our own shores provide homes for the winter visitors and also for birds simply picking up food in preparation for an onward journey south. Those that winter on British coasts have bred or were born in Greenland or north-eastern Canada, but in autumn our North Sea coasts provide temporary lodging for turnstones that breed in northern Europe; these birds then continue their journey southwards to winter in Africa.

Feeding on the rocks Although the purple sandpiper does not use its wader features–long bill and long legs–to enable it to probe in mud like its relatives, these features nevertheless serve it well on the rocky platforms where it is usually to be found. It is an agile bird, well able to run out of the way of advancing waves, but if it cannot run from a particular wave it hovers above the water until the

Birds of the rocky shore


Herring gulls
open shellfish such as mussels by dropping them on to rocks
Purple sandpipers
forage at the water's edge, moving with the tide, in search of food
Oystercatchers
use their long bills to prise apart or hammer open mussel shells
Turnstones
stoop to turn stones or expose seaweed on the strand-line in search of food items, mainly crustaceans
Eider ducks
can be seen diving to take food, principally mussels, from the rocky bottom
Rock pipits
breed in sheltered coves and gullies and feed on periwinkles and insect larvae, picked from stranded seaweed

wave has receded.

It is on gently shelving reefs, at the water's edge, that the purple sandpiper finds its food most easily. Here, the crustaceans and shellfish that it eats are active, whereas higher up the shore, where it is drier, the same animals tend to retreat into crevices, cling firmly to the rock or close their shells tightly in order to avoid the danger of desiccation.

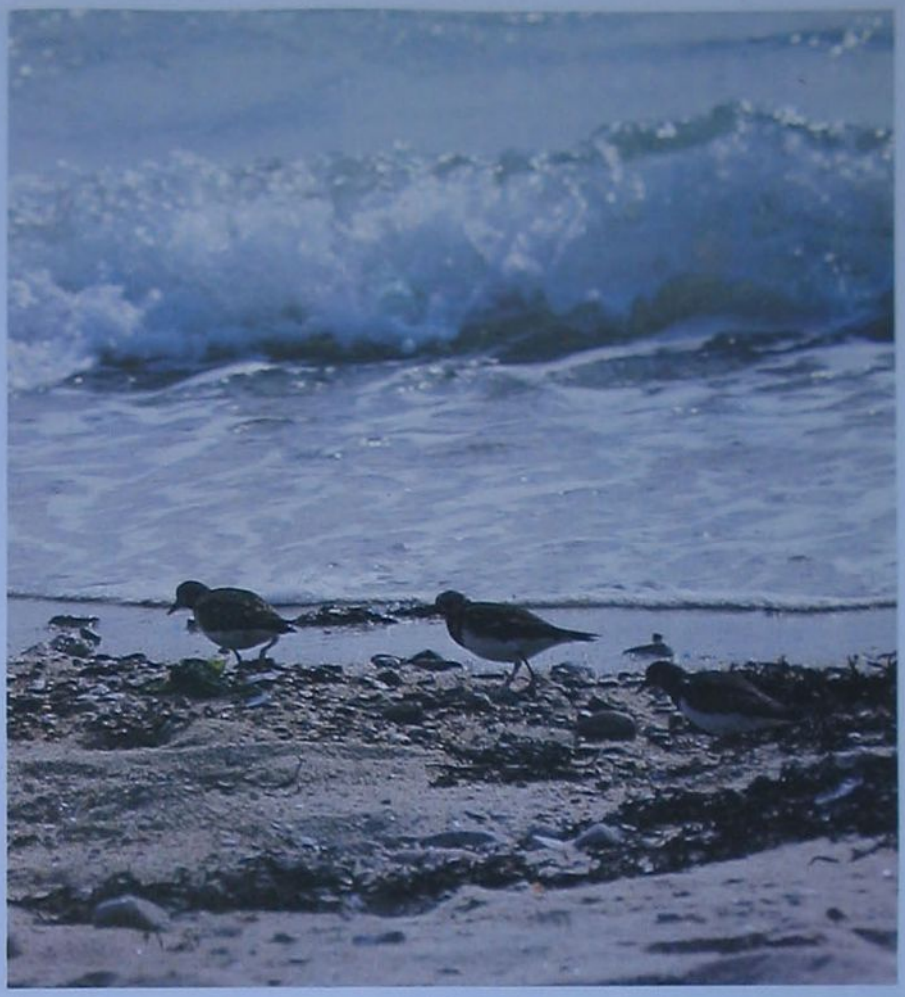
The purple sandpiper's diet is varied and consists of many of the common animals found on rocky shores. Small winkles and dogwhelks are taken in large numbers, while barnacles, mussels, tiny shore crabs, shrimps and even worms are eaten from time to time. Some of this variability in the diet is due to the birds' habit of feeding at the edge of the water, for as the tide moves in or out, so the different kinds of animal living at different levels on the shore become available for the birds to eat.

One problem for purple sandpipers in northern Britain is that high spring tides—submerging the reefs—can last all through the daylight hours; so they are forced to feed at night, or go inland during the day.

Varied feeding grounds Turnstones are altogether more versatile, both in the habitats in which they live and in the kinds of food they eat. Although they are commonly found on rocky shores, often feeding in mixed flocks with purple sandpipers, they are by no means restricted to these places. Estuaries, muddy and sandy beaches and even rubbish tips near the shore all support flocks of turnstones, while a visitor to the tropics is often surprised to find them in coastal coconut plantations.

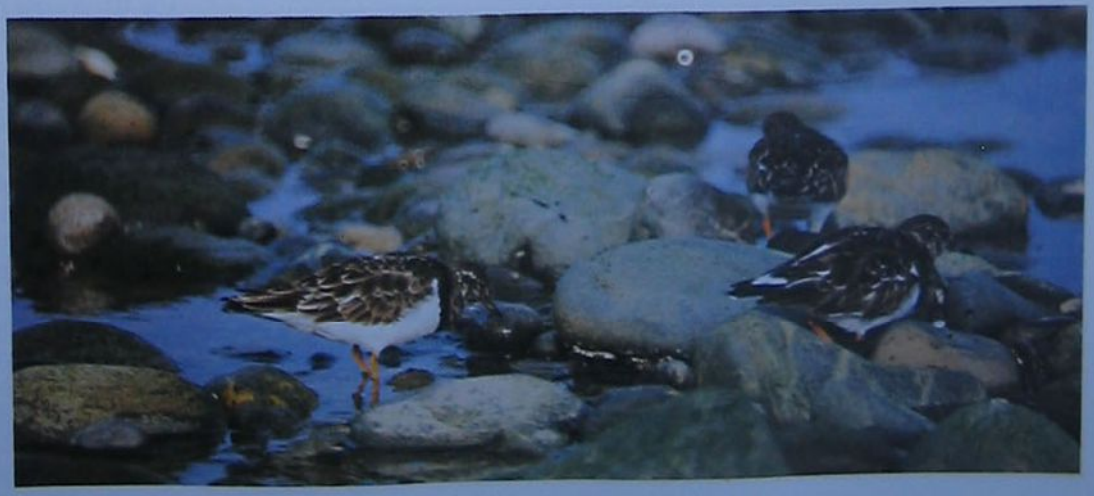
Turning over stones The turnstone has, in fact, a unique style of behaviour which enables it to move away from the water's edge and feed elsewhere. Even when the tide is out, some animals—the ones protected from drying out by being hidden under stones or seaweed—remain active on the shore. The turnstone does exactly as its name suggests and uses its short bill, squat body and strong neck to take advantage of these hidden resources. In all of this bird's feeding areas, one can see individuals running to stones or pieces of seaweed and flicking them over to expose whatever might be revealed beneath.

This is the winter behaviour of these squat-looking waders: both seem to be perpetually on the move, running energetically in search of small items on the rocks. But this is only a part of their life, for in spring they move north again to await the melting of the ice in remote Arctic regions. There they change their ways and become inland birds, dwelling away from the sea on the expansive, empty landscape of the tundra. They raise another brood in the short time available to them, and with their young they reinvade our shores after a brief season far to the north, in the land of the midnight sun.



Above: Turnstones feed in a variety of places. On rocky shores they take crustaceans and shellfish; on mud or sand (as seen here) their bills are too short for probing, and so they feed on shrimps, worms and shellfish exposed by the receding waves; they eat insects when found, and scavenge—picking at dead fish, birds and any other carcases washed ashore.

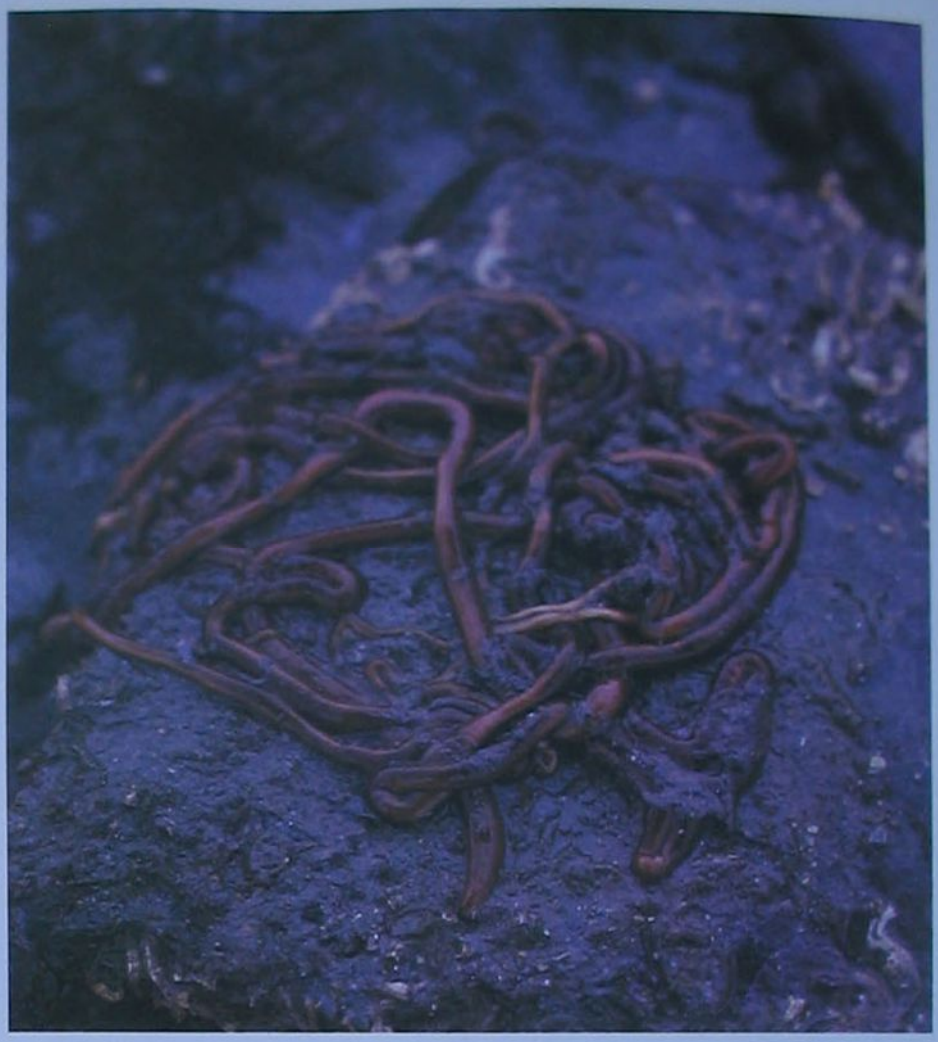
Below: A small party of turnstones investigating a stony beach.



Left: The rocky seashore provides nourishment for a special 'clientele' of birds. The herring gull cracks shellfish open by taking them overhead and then dropping them on the rocks; the eider duck dives for mussels on submerged rocks; the oystercatcher is often seen visiting rock pools; the rock pipit is found at low tide in almost any part of the rocky shore except in the sea; the purple sandpiper feeds at the water's edge—as does the turnstone.

RIBBON WORMS

Ribbon worms are long, thin animals whose fragile bodies belie the highly predatory life-style adopted by some species. Most can be found on the lower shore.



Above: This jumbled mass of creatures exposed on the rocks at low tide are bootlace worms (*Lineus longissimus*). This worm can reach enormous lengths—30m (98½ft) has been recorded, a length equal to that of the mighty blue whale. Normal specimens are, however, much shorter than this. The head of a bootlace worm bears a dense group of eyes on each side. The body narrows behind the head, but tapers only towards the tail.

As their name indicates, ribbon worms are extremely long, ribbon-shaped worms that may reach as much as 5m (16½ft) in length—although lengths of up to 10cm (4in) are more typical. There are about 650 species worldwide, most of which live on the sea-bed although some swim or float in the deep sea. One genus lives in fresh water and another is terrestrial in tropical and sub-tropical regions. A few species are commensal or parasitic, living in the gill chambers of crabs, the mantle cavities of bivalve molluscs or inside sea squirts.

Several species may be found on British shores at low tide, usually under stones or among seaweeds, and some ribbon worms live in semi-permanent burrows lined with mucus or in distinct tubes in sand or mud.

Ribbon worms are fragile creatures, and their bodies are often slimy due to the secretion of mucus which is needed to lubricate their movement. Locomotion, perhaps surprisingly when considering the worm's size, is carried out by the beating action of many minute hair-like cilia covering the body surface—the same method used by flatworms—combined with the contraction of muscles in the body wall. Ribbon worms share many anatomical features with flatworms, but have evolved a blood system carried by means of vessels, as well as a one-way gut with entry and exit at opposite ends of the body.

Feeding methods Ribbon worms have evolved a particular structure essential to their carnivorous life style. This is an eversible proboscis, and it gives rise to their other common name of proboscis worms. The worms feed on small invertebrates such as other worms, molluscs and crustaceans, or browse on carrion, and the proboscis is the major organ of food collection, although it may also be used in defence.

The proboscis is extruded from its own cavity, lying just above the gut, and when fully extended makes the long worms appear even longer. In some species the proboscis is armed with stylets and may, for example, be wrapped round a potential food source such as a worm before the stylets are stabbed into the struggling prey. Other ribbon worms may stab with the stylets first and immobilise the prey by the secretion of toxins from the proboscis. Alternatively, prey may be swallowed whole and killed by acid secretions in the foregut of the ribbon worm.

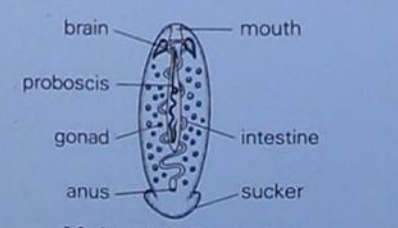
Reproduction Ribbon worms have separate sexes, and either male or female reproductive cells are scattered along each side of the body. In some species ducts may be developed to release the ripe gametes to the outside, and in others the body wall may rupture to release the eggs or sperm. Worms may come together in groups, or they may pair off in burrows to improve the chance of fertilisation, which usually takes place externally in the sea water.

The fertilised egg then develops into a

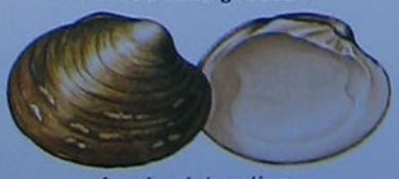
Ribbon worm lodger

Not all ribbon worms are long-bodied creatures which hunt prey. One species which does not fit the typical ribbon worm 'mould' is *Malacobdella grossa* (shown right).

This ribbon worm lives commensally inside the shell of the bivalve mollusc *Arctica islandica* (shown below), feeding on microscopic organisms gleaned from the feeding current of its host.



Malacobdella grossa



Arctica islandica

planktonic larva called a pilidium larva – so named because of its similarity in shape to a Greek helmet with a flap or lobe on either side. The ciliated larva feeds on plant plankton, and eventually settles on the bottom to develop into a juvenile worm. A central portion of the original larva drops out to form the worm – using as its first meal the discarded larval tissues.

In some species, especially deep sea species, fertilisation occurs internally, and the fertilised eggs develop in the female before hatching as miniature worms. Larger ribbon worms, in particular, also show asexual reproduction, spontaneously fragmenting into many pieces, each one of which develops into a new worm.

Some common British species The commonest British intertidal ribbon worm is the red-line worm (*Lineus ruber*) – a reddish, brown worm about 10cm (4in) long. The red-line worm is found under stones or in muddy gravel at the bottom of the shore and beyond, and feeds on bristleworms, which it engulfs whole with the aid of its proboscis. This worm is extremely tolerant of reduced salinities and will penetrate into estuaries, often being found in saltmarsh pools.

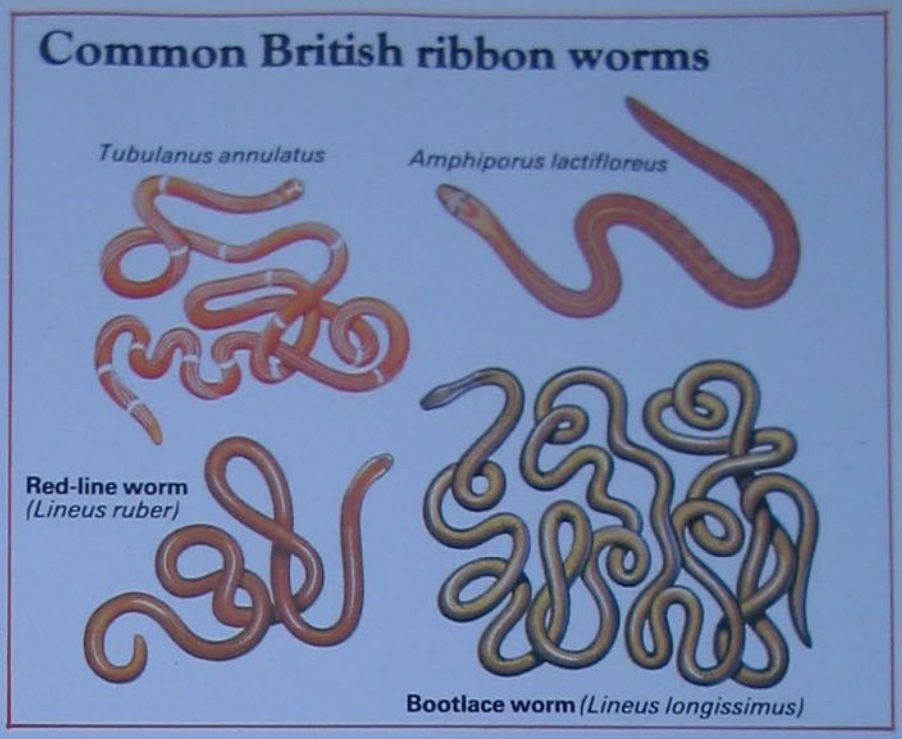
A close relative of the red-line worm is the bootlace worm (*Lineus longissimus*) which, as its specific name implies, is immensely long, reaching up to 5m (16½ft) or more. One specimen has even been found to be as long as 30m (98½ft). It is a brown worm, often found in tangles under stones or around kelp holdfasts on the lower shore. It contracts into tight knots and fragments easily if any attempts are made to unravel it.

A strikingly coloured British ribbon worm is *Tubulanus annulatus*, a narrow-bodied red worm with white stripes found in tubes of mucus in sand, under stones or in crevices at the bottom of the shore. It may reach 70cm (28in) in length.

The pink ribbon worm *Amphiporus lactifloreus* – which may also tend towards white or grey in colour – is up to 8cm (3in) long, with marginal rows of eyes sited on either side of its head. A translucent line, often visible along its back, is actually the retracted proboscis which is as long as the body. This ribbon worm traps its amphipod crustacean prey with its proboscis and discharges a toxin powerful enough to kill it in 40 seconds. The worm then searches out a weak spot in the exoskeleton of its victim, into which it inserts its head. The stomach is protruded and enzymes are secreted to digest the contents of the crustacean which are then sucked up into the gut of the worm.

As well as these more typical ribbon worms, there are also some unusual species to be found. *Malacobdella grossa* is a leech-like worm living commensally in the mantle cavity of the bivalve *Arctica islandica*. It holds on by means of a large posterior sucker, and moves in a leech-like looping motion. *Malacobdella* feeds on microscopic planktonic organisms filtered from the current produced by its host, but occasionally takes larger prey.

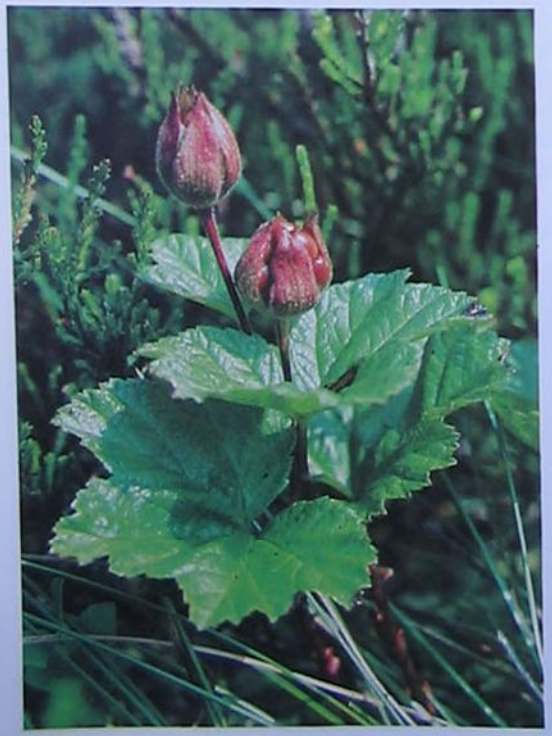
Carcinonemertes is a genus of ribbon worm parasitic on crabs, particularly swimming crabs. Usually only female crabs are infected, for the juvenile worms feed on the crab's eggs before becoming sexually mature themselves.



cilia (fine hairs) beat to create feeding currents
apical sensory tuft
blind mid-gut
mouth
food particles are wafted into the mouth and ingested
Pilidium larva

Above: The pilidium larva is a planktonic stage in the ribbon worm life-cycle and allows dispersal of the species. Species of *Lineus* do not have the pilidium larval stage, but instead have a non-feeding larva which remains in the egg-membrane and develops on the sea bottom. Although wide dispersal is thus sacrificed, it attracts less attention from predators.

Right: *Tubulanus annulatus*, seen here with its unmistakably marked body. Ribbon worms are easily distinguished from the more numerous and successful bristleworms (such as *Nereis*) by the fact that they lack the characteristic segmented body arrangement of the bristleworms. This lack of segmentation means that ribbon worms do not have the associated hydrostatic skeleton, and so are limited in the amount of body movements they can perform.

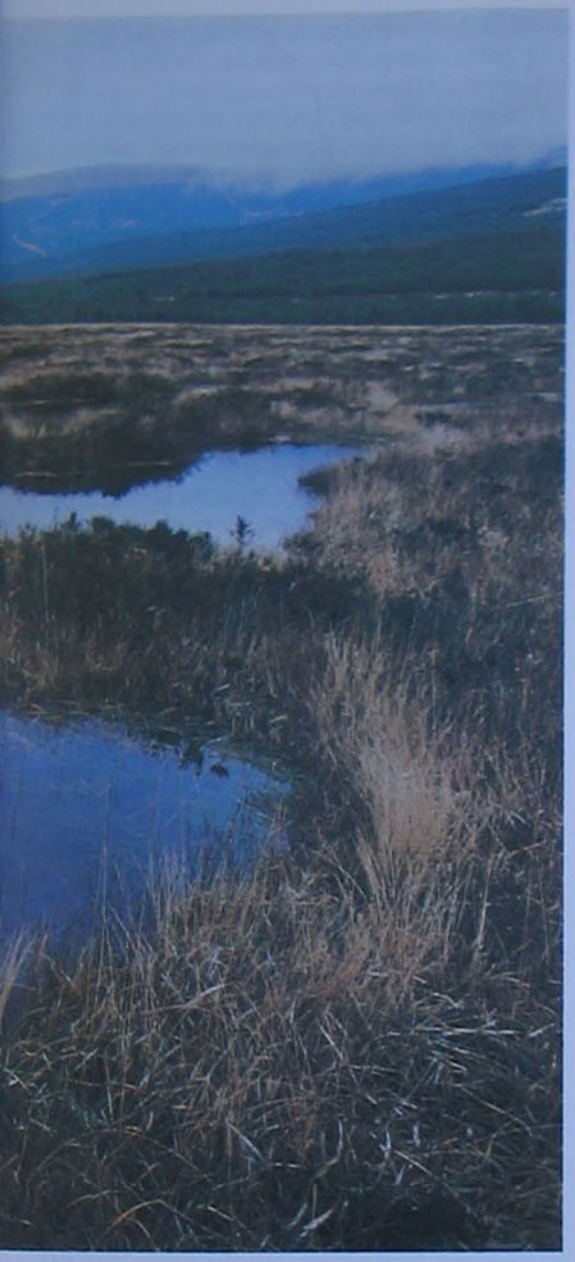


BLANKET BOGS: A CLOAK OF PEAT

Most of our 'moorland' is more accurately described as blanket bog. The Pennines, Dartmoor, upland Wales and many of Scotland's heather-covered moors consist largely of blanket bog – wild, untamed land still awaiting the first cut of the plough.

Left: Cloudberry plant just coming into fruit. This plant is found on many of our blanket bogs.

To some extent the general concept of bogs as dismal places is well-founded because blanket bogs depend for their formation first and foremost on the climate – the wetter the better. Britain lies directly in the path of moisture-laden westerly air-streams that sweep in from the Atlantic, bringing the rain which is literally the life-blood of our moorland areas.



Above: Sphagnum moss—a riot of colour. That tiny bog mosses like this could have such profound effects over a wide area of Britain seems incredible, but the whole development of blanket bogs is closely bound up with this small but extremely important group of bryophytes.

Left: Pool and hummock bog—although such areas appear to be bleak, barren wastelands, they actually harbour many of our most fascinating and unusual plant species—most notable among them being the carnivorous butterworts, bladderworts and sundews.

Below: Long-leaved sundew—you can find all three of Britain's sundew species on blanket bogs.

The sphagnum blanket The process of blanket bog formation begins with the damp climate maintaining a waterlogged soil. This, together with the hard, acid rocks which dominate most of our northern and upland areas, combine to produce particularly difficult conditions for plant growth. However, species of the genus *Sphagnum* (bog moss) are superbly adapted to such conditions. Where waterlogging is particularly acute, such as in shallow basins, broad plateaux and gentle slopes, the small but brightly coloured bog mosses gradually form extensive carpets that cloak the thin, sodden soil.

Looked at under the microscope, the leaf of a sphagnum moss is seen to consist of extremely narrow, living green cells (containing chlorophyll) that are squeezed between, and dwarfed by, enormous empty cells (hyaline cells) which make up the bulk of the leaf. These hyaline cells are used for water storage—with cells this size the sphagnum plant is able to hold many times its own weight of water. Consequently, as sphagnum forms its 'carpets', the ground, already wet from the rainfall, becomes increasingly sodden because the sphagnum carpets are able to absorb and bind the majority of the rain where it falls.

Such conditions disrupt the usual course of biological growth, death and decomposition—the most efficient bacteria involved in decomposition require oxygen, which is not available because of the high water table. Anaerobic bacteria (those requiring no oxygen) are able to begin the process, but are much less efficient and therefore unable to achieve complete decomposition. Consequently the dead remains of the previous year's growth slowly accumulate beneath the living sphagnum layer. (We are generally more familiar with this accumulation of dead but undecomposed bog moss as 'peat'.)

Formation and development It appears that extensive blanket bog formation began about 5000BC when Britain's climate was extremely wet and fairly warm. Growth of the moss carpets is not rapid—about 2mm a year is the average—but over a period of six to seven thousand years this has been quite sufficient

Above: Red grouse (female) sitting on her nest. This species is attracted to blanket bogs to feed on such plant species as heath. Oddly enough, heather, although always associated with moorlands, plays only a small part in most blanket bog vegetation. It is a species intolerant of extremely wet conditions and therefore generally restricted to the higher hummocks. Only on the thinner, much steeper soils does it form its broad purple sheets. Its place on the true blanket bog is taken by cross-leaved heath which, with its delicate pink flowers, is often mistaken for bell-heather. However, bell-heather is a plant of thin peat in the far west of Britain, while cross-leaved heath occurs mainly on deeper peats.

to produce peat depths of up to 5m (16ft). Whole landscapes have vanished under layers of peat several feet thick because the original nuclei of peat developing in the hollows, on level ground and on gentle slopes began to coalesce to form a complete blanket, leaving exposed only the steepest slopes (30 degrees or more) where water is still able to drain freely.

Surprisingly, the bog surface remains waterlogged, even though it may be perched 5m (16ft) above the mineral soil, because the power of sphagnum to bind water is stronger than the pull of gravity. Walk across the surface of a deep blanket bog–even when it covers a gentle slope–and it will be soft and spongy, sometimes quaking, and often (at least in the far north and west) riddled with a maze of peaty bog pools or *dubh lochans* (*dubh* meaning black and *lochan* being a small lake).

The actual nature of the surface patterns is largely controlled by the climate. The relatively dry conditions of the Pennines (about 1500mm/59in of rain a year) allow ample time for the majority of surface water to run off the downslope or evaporate. Pools of open water are therefore comparatively rare on the Pennine peats, the surface instead consisting of hummocks of bog mosses separated by shallow damp hollows. The far north-west of Scotland, on the other hand, has almost 2300mm (90½in) of rain each year. Such a volume of water cannot possibly be lost entirely through run-off and evaporation, and the excess collects as pools. In time these pools become established in complex but stable patterns, the nature of these patterns being determined by the type of blanket bog formation.

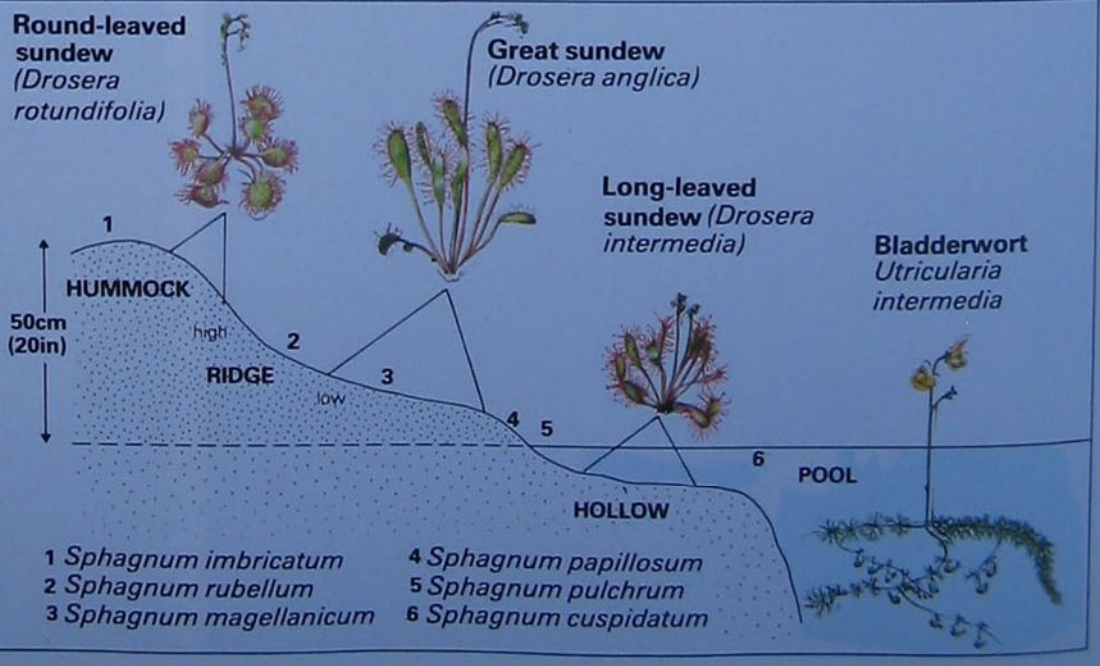
Types of blanket bog Watershed bogs are those occupying the broad, level ridges of ground that form watersheds between river systems. Here the pools tend to be broadly circular, often several feet deep, and separated by wide ridges of drier bog vegetation.

Valley-side flows, as their name suggests, occupy the gently sloping ground of river valleys. At times this can mean a surface slope of up to 20 degrees, but the pools formed on these slopes are quite stable. Each pool is very narrow (up to 1m/3ft across) but extremely long (sometimes as much as 50m/164ft), and lies along the slope, parallel to the contours. Between this pool and the next is a ridge of peat, equally long and narrow, dominated by drier bog vegetation; downslope from this is the next pool. Remarkably, although these two pools may be separated by only a narrow ridge of peat, the difference in water level between the two pools may be as much as 50cm (20in). That such a pattern can remain stable is due entirely to the water-retaining properties of sphagnum peat. From the air these surface patterns resemble strange, alien landscapes, but for the species which inhabit them they are the major source of habitat diversity in an otherwise unbroken landscape. Even so, the highest hummocks barely reach 1m (3ft) high.

Carnivores of the plant world Most plants

Blanket bog plants

The insectivorous plants of Britain's blanket bogs are distributed in a variety of quite specific areas. The round-leaved sundew, for instance, is found on the hummocks, the great sundew on and around the pool margins and the long-leaved sundew in shallow hollows. Bladderwort flourishes in the bog pools. Each species of sphagnum (nos 1-6) also has its own distinctive place in the surface patterns of the blanket bog. They carpet the ground in brilliant colours.



find the constantly high water table of a bog intolerable, and the thickness of peat prevents even the deepest-rooting species from reaching the subsoil. The peat itself offers little in the way of nutrients; indeed, the major source of minerals available to the growing surface once the peat layer is more than 60-90cm (2-3ft) thick is the very rain that started the whole process off. Clearly this is a miserably poor input, but species must either find this sufficient or else make use of alternative sources.

Perhaps the most famous of these alternatives is that utilised by the carnivorous plants – the sundews, bladderworts and butterworts. Anyone who has been on a walking holiday in Scotland in mid-summer will be aware that the moors are inhabited by swarms of bloodthirsty midges and horse-flies or clegs. Here is ample food for the sticky leaf-glands of the sundews to trap and digest slowly, releasing vital nutrients to the plant. All three species of British sundew – the round-leaved, great and long-leaved – are found on our blanket bogs, each inhabiting a slightly different part of the surface pattern. The round-leaved sundew occurs on hummocks, the great sundew along the pool margins and the long-leaved sundew in shallow hollows. Butterwort, another carnivorous species, traps insects like the sundews but makes its leaves rather more slippery than sticky. Insects are therefore unable to crawl round the upcurled leaf edges and become trapped, to be slowly digested by the glands on the leaf surface. Bladderwort, found in the bog pools, uses a more violent method of ambush: trailing from the leaves are a number of small bladders, each of which has a hair trigger. When this is brushed by a passing water flea, the lid of the bladder flips open, water and the unfortunate flea are sucked in, and the lid snaps shut.

Another well-known species of blanket bogs is common cottongrass. The russet glow its leaves give to the vegetation cover in the autumn is often a clear and simple guide to the wettest areas of ground; in Orkney its white cotton seed heads were traditionally gathered, spun and woven into bridal stockings. In the early spring by far the most vivid splashes of colour are provided by a small lily, the bog asphodel.

To all these other colours, the moss carpet itself adds its own vivid swathes of greens, yellows, oranges, reds and browns. Each species of sphagnum has its own place in the surface patterns, and each is characterised by its own distinctive colouring.

Blanket bog animals Compared to the bustling life of a woodland, a blanket bog can, at first sight, appear to be a bleak and lifeless place – but appearances can be deceptive. This is red deer and grouse country, and golden eagles soar on thermals above the bogs, while merlins flash by, hugging the ground to pick off startled meadow pipits. Short-eared owls quarter the ground on stiff, bowed wings, while hen harriers drift low over the ground on V-shaped wings, waiting to snatch up small birds and nestlings.

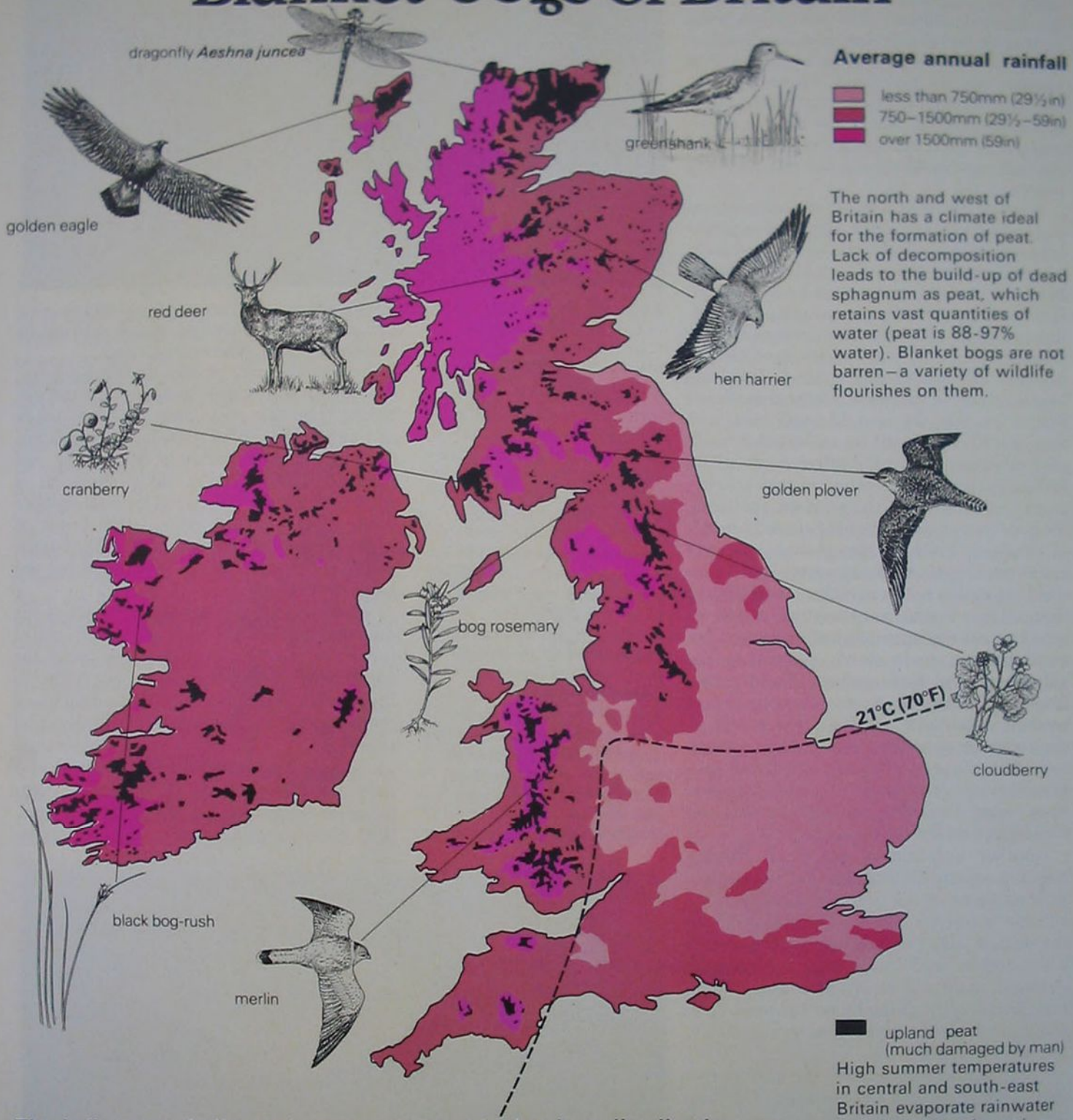
Above: A bird to watch for in the sky over northern blanket bogs – the magnificent golden eagle.

Below: Blanket bogs like this are under threat. Huge areas of blanket bogs are being ploughed for forestry, as here, other areas have been earmarked for possible use in peat-fuelled power stations, a number of farmers are attempting to transform peat into rye-grass pasture and, most insidious of all, the practice of hill-burning or 'muirburn' (carried out to encourage the growth of heather) is destroying thousands of acres of the very ground it claims to improve. Burning destroys the living layer of sphagnum and without its living layer a blanket bog cannot grow; instead it slowly decomposes.

Adders, too, can be seen on blanket bogs, basking on warm moss hummocks in the sun before slithering off to hunt for frogs, toads or newts in the small pools, and dragonflies such as the black darter or the metallic red damselfly patrol these same pools in a rhythmic dance, swooping to grab smaller flying insects. In the pools larval forms of insects chase and are chased by other larvae, while adult water beetles prey on all but the largest of these.

Above all, capturing the very essence of our moorlands with their haunting and evocative cries, are two birds – waders that spend the winter feeding on our estuaries but return to the hills in the spring to breed. The dunlin and the golden plover are almost invariably found together, so much so that in the Pennines their association has earned the diminutive dunlin the name 'plover's page'. Both run from hummock to hummock on clockwork-like legs, their plaintive calls travelling vast distances.

Blanket bogs of Britain



Average annual rainfall

- less than 750mm (29½in)
- 750–1500mm (29½–59in)
- over 1500mm (59in)

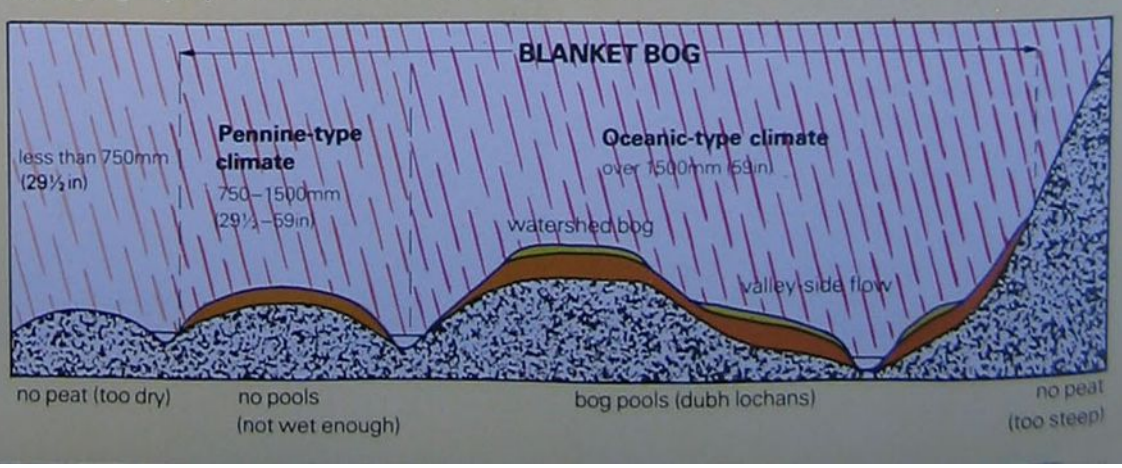
The north and west of Britain has a climate ideal for the formation of peat. Lack of decomposition leads to the build-up of dead sphagnum as peat, which retains vast quantities of water (peat is 88-97% water). Blanket bogs are not barren—a variety of wildlife flourishes on them.

upland peat (much damaged by man)

High summer temperatures in central and south-east Britain evaporate rainwater and inhibit peat formation.

The influence of climate/topography on blanket bog distribution

Blanket bog can form in any area where the annual rainfall is more than 750mm (29½in)—except where high summer temperatures evaporate the water quickly. Excess surface water collects as pools with ridges of peat between, the surface patterns varying according to climate and slope. Shown here are three types.



- peat
- peat with dubh lochans

POISONOUS TIGER MOTHS

Tiger moths are recognised by their flamboyantly coloured wings, which warn potential predators that they are extremely unpalatable.

Tiger moths belong to the family Arctiidae, which claims about 35 British species, although a few are no more than accidental strays from the Continent and should not be regarded as native. Many of the species are rather small and inconspicuous and lack the typical 'tiger' markings–since they do not possess this warning coloration they are probably not particularly poisonous. The common name 'tiger' is reserved for the larger, brighter coloured species which are poisonous.

Danger signals With its brick-red black-spotted hindwings and white chocolate-blotched forewings, the garden tiger must be one of Britain's gaudiest moths. Its flamboyant colouring immediately attracts the attention of even the most casual observer. Although common everywhere, it is more often encountered at night, when it is attracted to lights.

The strong colouring of the garden tiger is a perfect example of warning coloration in insects–few moths can be more unpalatable to potential predators. The garden tiger's body tissues have been found to contain several different chemical substances, including a kind of heart poison. These substances are acquired while the caterpillar is feeding on plants which contain them in their leaves. They are present in plants to deter insects, including caterpillars, from attacking them.

Above: The garden tiger moth (*Arctia caja*) must rank as one of our gaudiest moths. Its flamboyant colouring protects it from predators, warning them of its most unpalatable taste. One moth's poison is sufficient to upset the stomach of a small insect-eating bird.

Below: The caterpillar of the garden tiger moth is covered with a thick coat of long, dark brown hairs which give it the common name–'woolly bear'.

Above: The Jersey tiger moth (*Euplagia quadripunctaria*) is mainly nocturnal, although it is frequently seen by day since it flies out of vegetation when disturbed.

Left: The hairy black caterpillar of the Jersey tiger is easily identified by the orange stripe along its back and the white spots on its sides.

Below: Three tiger moths with their caterpillars on the larval foodplants.

but many plant-eating insects have evolved immunity to the poisons and some species, like the garden tiger, store them through the caterpillar and pupal stages and incorporate them into the tissues of the adult moth.

The garden tiger also manufactures some poisons of its own, including a histamine-like substance. The amount of poison in an individual tiger moth is too small to affect a human, but is quite sufficient to upset a small insect-eating bird. Birds will not touch them, unless they are extremely hungry or inexperienced – even house sparrows, which appear to eat almost anything, leave garden tigers alone.

Female garden tigers lay their eggs at night on almost any herbaceous plant, including weeds like nettle, and on many garden ornamentals. The young caterpillars, known commonly, because of their hairiness, as woolly bears, feed for a short while in the autumn, but are not often seen as they hibernate among dead vegetation when quite small.

The caterpillars reappear in the spring on sunny days, as they grow becoming more and more conspicuous. They spend much of their time basking in the sun and scientists assume that their dark colouring enables them to absorb the sun's warmth, which in turn makes them active and able to feed more rapidly. When fully grown the caterpillars leave the foodplant and spin a flimsy cocoon in which to pupate. The moths appear in July and are on the wing throughout August.

Coastal tiger Equally striking, although not quite so outrageously coloured, is the slightly smaller cream-spot tiger which has black, yellow-spotted forewings and deep yellow, black-spotted hindwings. Its life-cycle is similar to that of the garden tiger, but it flies earlier in the season – in May and June. The woolly bear caterpillars feed mainly on nettles, although they are also found on other weeds such as dandelion, groundsel and dock.

The cream-spot is a rural moth – it is rarely found in towns and gardens – and appears to prefer coastal areas. Its distribution is patchy and more or less confined to the south, especially the south-west. Sadly, the population seems to be decreasing.

Cream-spot tiger moth *(Arctia villica)*

Wood tiger moth *(Parasemia plantaginis)*

Ruby tiger moth *(Phragmatobia fuliginosa)*

Foreign species The Jersey tiger is similar to the garden tiger in size and appearance although it has only three black spots on its crimson hindwings, as opposed to the five or six on the garden tiger.

It is more common today than in the past and is found at various localities on the south-west coast – notably in Devon, where in some years it may be extremely abundant. Although mainly nocturnal, it is easy to find by day since it flies out of vegetation if disturbed.

It is possible that the Jersey tiger colonized Britain only recently, since it was first seen in 1855 in Sussex and did not appear in Devon – its present stronghold – until 1871. Entomologists had been observing moths long before these dates and such a conspicuous species could not have been missed. One explanation for its recent colonization is that it was deliberately introduced from France, or more probably the Channel Islands, where it is extremely common.

Day-flying tiger moths The scarlet tiger has white and yellow-spotted black forewings and crimson hindwings marked with black – another variation on the 'tiger' theme. It flies by day, and sometimes at night, in June in damp marshy places, where its yellow and black hairy caterpillars may be seen feeding on nettles and comfrey. The moth is extremely local in the south of England and forms well-defined colonies – some of these are established on nature reserves where they are completely protected.

Another day-flyer, the wood tiger, is more common in the north than the south and occurs in two particularly different habitats – heathland and downland. June is the month to find this moth, which is considerably smaller than the other tiger moths and has yellow and cream wings with the usual black tiger markings.

The males fly by day and may be seen careering rapidly through the air searching for newly emerged females. The latter rarely fly, and when they do it is at night. The caterpillars are usually found in April and May (after hibernation), sunning themselves on vegetation and feeding on low-growing plants such as plantain.

Ruby tiger This species is different from all those described above since it lacks the characteristic tiger markings. Nevertheless it is sufficiently brightly coloured, with its reddish-brown forewings and ruby-red hindwings shaded with black, to warrant being included in this group. In the north of Britain specimens are darker and a paler shade of red.

The ruby tiger is a night-flyer, and occurs almost everywhere, although it is most frequently found in gardens. Unlike other 'tigers' it has two or possibly even three breeding generations a year, and is therefore found at almost any time from spring to autumn. The blackish hairy caterpillars feed on virtually any low-growing plant, including most common garden weeds.

Above: Scarlet tiger moths (*Callimorpha dominula*) are not widely distributed in the British Isles, occurring only in a few well-defined colonies in the south. They prefer boggy land, although they have been sighted in gardens around Oxford – probably the result of chance establishment from moths released by research workers. Their black furry caterpillars with bands of yellow spots (right), hatch from eggs in July, and may be seen feeding on a variety of plants including dead-nettle during the summer. They hibernate for winter and resume feeding in April and May. When fully grown the chrysalids form in silk cocoons which hang from vegetation. The adults finally emerge in June.

Counting insects – a population census

Have you ever wondered how insect population numbers are estimated? For species such as the scarlet tiger moth, which form discrete colonies in confined areas, a technique known as 'capture-mark-recapture' is used. A random sample of one species of moth is caught with an ordinary insect net, each one is marked on the wing with a small spot of ink (a felt pen is ideal) and then immediately released. A few days later a second sample is caught and the proportion of marked and unmarked individuals is used to estimate the size of the population – if the number of moths inked in the first sample is multiplied by the number of moths actually caught in the second sample and the result divided by the number of moths which have ink marks in the second sample, the final sum tells you the size of the population on that particular site. The method works well for colony-forming moths which are restricted to a small area, but it cannot be used for wide ranging species like the garden tiger.

COLONIAL MOSS ANIMALS

More than 200 species of moss animals have been identified in British seas, but only a few are known from fresh water. Efficient suspension feeders, they compete with other organisms for living space on piers, pilings, stones, seaweeds and stems.

Moss animals or bryozoans are tiny aquatic animals living in colonies, sometimes in vast numbers. Most of them are marine but a few species can be found in fresh water. Moss animals either encrust algae and other solid objects in shallow waters or form frond-like colonies superficially resembling algae.

The classification of these minute creatures is complex. Essentially, they are divided into three classes: the Phylactolaemata, which live in fresh water (for example *Cristatella* and *Plumatella*); the Stenolaemata, which live in the sea (for example *Bowerbankia* and *Crisia*); and the Gymnolaemata, also living in the sea (for example *Alcyonidium*, *Electra*, *Flustra*, *Membranipora*, *Bugula* and *Pentapora*).

Body structure Each moss animal colony is made up of individuals, called zooids. Individual zooids are very small, many of them less than 1mm long. The body of a zooid may be cylindrical, oval or box-like in shape and is protected on the outside by a horny or chalky skeletal capsule. There is no head but the bilaterally symmetrical body bears a food-catching organ called a lophophore – a ring of hollow tentacles at the front end. Each tentacle is covered with many cilia which waft a current of water through the lophophore, bringing with it oxygen and suspended food particles. The mouth lies in the middle of this ring and a short looped gut leads from it and then returns to the anus, which opens behind the lophophore. The lophophore can be withdrawn into the protective case of the animal to prevent damage from predators. In some species there is also a flap-like lid, the operculum, which can be closed like the lid of a box for safety.

In order to protrude the lophophore, the moss animal needs to be able to change the volume of its body cavity. The walls of the body cavity are flexible, so that muscles can act on them to increase the pressure within and squeeze out the lophophore. As the body walls are stiffened by horny or chalky material this becomes difficult and one wall, usually the upper one in a flat individual, therefore has to remain unprotected by the skeleton. This unfortunately makes attack by sucking predators like sea-spiders easy. A remarkable series of fixed structures, ranging from spines through rib-like bars to plates with sieve holes, have therefore been evolved to protect the moveable membrane and so preserve the ability to protrude and retract the feeding and respiratory tentacles.

Possibly because of their small size, these animals require no circulatory system, but the body cavity does accommodate reproductive organs.

Moss animal reproduction Many species of moss animals are hermaphrodite. Generally, a fertilised egg develops into a free-swimming larva which, after a period of feeding among the plankton, settles and metamorphoses into an adult capable of forming a new colony. In

Above: A rose 'coral', *Pentapora foliacea*, taken from the sub-littoral zone around Guernsey. Not a coral at all, but a calcified colony of moss animals, it is easily recognised by its folded pinkish growth pattern. Note the small crabs sheltering in the crevices.

Right: *Flustra foliacea* – often present in large beds offshore, this species may provide a habitat for a wealth of other small animals. It is known as hornwrack, although it is in no way related to the wracks. Each 'frond' in the colony consists of two layers of zooids, back to back, and looks superficially plant-like. *Flustra* is not a shore form, but is occasionally washed up on shores.

some species the fertilised egg is held in a pouch on the outside of the parent until the larva has formed.

The individual that settles down after metamorphosis is the first member of the new colony and is known as the ancestrula. From it the rest of the colony develops by budding off (a form of asexual reproduction). Many individuals live side by side, sharing common structural features. Some individuals are organically connected; others merely touch their neighbours. Some of the marine species, such as *Bugula*, show polymorphism: most individuals in the colony carry out basic activities such as food collecting and reproduction, but some are highly specialised for other tasks, including defence.

Colonial life Colonies of moss animals live attached to other objects–encrusting freshwater tree roots, the stems of aquatic plants, rocks and shells in the sea and algal fronds. Because of their attached habit, they are active competitors for space and are able to utilise almost any satisfactory surface. Those species that colonize rocks and shells do not compete well with algae, so tend to flourish in shady places where there is not enough light for plants.

The term sea-mat is applied to marine moss animals such as *Membranipora* and *Electra* which have flat, encrusting growths. Here the colony is only one individual thick and takes up quite a lot of space. Such a colony is restricted to exploiting the water currents that pass immediately beside the substrate on which it is growing.

With the pressure for attachment space always high because of competition from such animals as sponges, hydroids and sea-squirts, some moss animals have evolved an erect or pendulous form of growth. This not only reduces the space needed for attachment, making the species less vulnerable to the effects of competitors, but also lifts the feeding animals away from the substrate so they are able to exploit richer water currents above the sea-bed. *Flustra* and *Bugula* both show this type of growth.

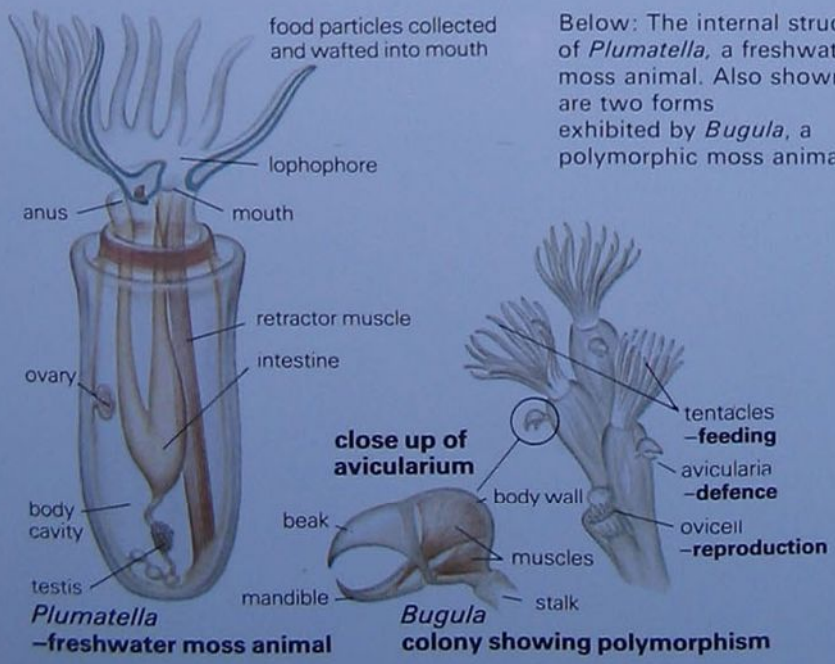
Polymorphism Certain types of Gymnolaemata have evolved polymorphs (more than one form). These polymorphs are involved in the defence of the colony and take two forms–vibracula and avicularia. Vibracula are like waving bristles and have evolved from the opercula of feeding individuals. They oscillate back and forth in order to generate currents and so prevent the colony clogging with silt and detritus.

Avicularia are individuals, resembling a microscopic bird's head and beak, which trap intruders such as small crustaceans creeping over the colony. They function rather like a mouse-trap, with small muscles to open the beak and powerful ones to snap it shut when the intruding organism touches the delicate tactile receptor.

Above: Sea-mat moss animals under water with their fine, almost transparent tentacles exposed. The colony is sitting on the surface of a seaweed and is viewed under a low power microscope.

Right: Moss animals can take many different shapes. This is *Electra pilosa*, a marine species belonging to the class Gymnolaemata. Until recently moss animals were little studied, probably because of their small size and apparent lack of importance. More recently, however, their ecological significance and economic importance have been appreciated. A number of species flourish on buoys and other man-made structures such as piers and pilings and can 'foul' them sufficiently badly to be of economic significance.

Moss animal structure



Below: The internal structure of *Plumatella*, a freshwater moss animal. Also shown are two forms exhibited by *Bugula*, a polymorphic moss animal.

SQUIRRELS: PAST, PRESENT, FUTURE

The relationship between our native red and introduced grey squirrels, and their dramatic changes in fortune this century, have provided an intriguing biological problem. Britain is the only place where this natural 'experiment' has occurred.

Red squirrels have lived in the British Isles for over 9000 years, arriving across the landbridge that joined us to Continental Europe after the most recent Ice Age. They migrated northwards and gradually colonized the whole country up to an altitude of about 650m (2130ft). In contrast, grey squirrels, first introduced from their native North America in 1876, have a short history as a British species.

Early days Since man started to clear and alter woodlands the arboreal red squirrels have declined in numbers. Evidence confirms that their populations have fluctuated dramatically in historic times. They became extinct in southern Scotland and Ireland by the early 18th century, and reached the verge of extinction in the Scottish Highlands in the late 18th century. Between 1772 and 1872 they were reintroduced to Scotland and Ireland from English and Continental sources. There was a rapid recovery followed by superabundance in the 1890s, but two extensive declines occurred this century, separated by partial recovery in the 1930s.

Grey squirrels were released or escaped from amenity parks, and by the 1920s were well established in the wild. They spread rapidly up to the 1950s, when the different centres of introduction in England and Wales coalesced, with the expansion continuing more slowly to the present. The Scottish and Irish populations have spread less rapidly.

Different life-styles Red squirrels became primarily adapted to the blanketing postglacial Scots pine forests. The pines provided numerous foods (mainly seeds, but also leaf buds, shoots, needles, flower buds, pollen and sappy tissue), escape cover, materials and sites for nests. The hazel understorey provided a useful additional source of food and may help to explain the ease of the red squirrels' subsequent secondary adaptation to pure deciduous woodlands. The pine forests declined quite naturally over lowland Britain as the climate became warmer and wetter some 7000 years ago, and were gradually replaced by mixed deciduous forests, with pine becoming confined to upland Scotland. From about 5500 years ago there were further changes as Neolithic man started to exploit and then coppice woodlands. The widespread and familiar management system of hazel coppice with oak standards, developed in Saxon and Medieval times, was also advantageous to red squirrels. Thus red squirrels lived through periods of great change by adapting to less favourable types of deciduous woodland.

In mainland Europe two colour forms of red squirrels interbreed freely to produce a range of intermediates. The familiar chestnut-red form is most frequent in the temperate lowlands, particularly in pine and oak woodland, whereas the dark brown form predominates in colder places and at higher altitudes, especially in spruce/fir and beech woodland. Our own island race of red squirrel, characterised by summer bleaching of tail and ear tufts, exhibits only the chestnut-red phase; any dark brown squirrels seen in Britain today result from Continental introductions over the last two centuries.

Grey squirrels in Britain have adapted to our mature deciduous woodlands, large or small, particularly those containing oak. The habitat remains favourable even where there is a large proportion of conifers within the woodland. In North America the 'eastern gray' squirrels primarily inhabit large deciduous woodlands, particularly those with oak, hickory and walnut.

Present status The past history and life-styles of the two species are relevant to their status today. The two declines of red squirrels cannot be attributed directly to the introduction of grey squirrels. They were the latest in a continuous series of ups and downs, caused in the short term by variations in food supply, in turn affected by climate, and in the longer term by major woodland habitat changes due to man's intervention, particularly the losses and gains of suitable mature trees. The first decline was, in any case, in the absence of

Above: The native red squirrel is regarded as our most endearing wild mammal. Yet at the turn of the century it was considered a pest of farm and forest. Tame red squirrels were frequent in urban parks – much like their close relative the introduced grey squirrel (opposite) today. The grey squirrel has had a bad press as the so-called 'tree-rat', although many city-dwellers find it captivating.

Below: Red squirrels thrive in greatest abundance in our modern, dense, mature and even-aged conifer plantations. This forest in Fife contains 47 year old Scots pines bearing a large and reliable cone crop and supporting plenty of red squirrels.

Above: A grey squirrel in its favoured broadleaved habitat. Grey squirrels strip bark from deciduous timber trees, particularly beech and sycamore. Control techniques are best applied just before and during the spring period when damage is most acute.
In North America grey squirrels are highly prized game for food and pelts, and their stocks are conserved by close seasons and habitat management. In many other parts of Europe red squirrels are valued for providing sport, food and fur.

Below: A grey squirrel drey high in a tree. The arboreal habit of grey squirrels means that they are relatively safe from predators.

established grey squirrels, while the most recent and continuing decline since the mid-1940s has occurred in areas both with and without grey squirrels. There is no evidence of direct aggression between the species affecting the picture.

Both species do, however, suffer from epidemic disease, outbreaks of which often accompany red squirrel declines. It has been suggested that grey squirrels brought with them a disease to which red squirrels are much more susceptible, but there is no evidence that the disease is new. Although disease may be responsible for many red squirrel deaths, it is more likely to be a symptom rather than the cause of the decline, which has been produced initially by habitat loss or alteration.

Grey squirrels have filled the vacuum left by the latest red squirrel decline, moving into the suitable deciduous and mixed woodlands predominating over southern Britain, and so precluding the future return of the red squirrels to their former haunts. Thus the alien grey squirrels in Britain are now occupying the same continuous deciduous woodland niche they inhabit in their native country, plus the fragmented woodland habitat that their relatives, the larger fox squirrels, occupy in North America. Grey squirrels seem to retain the competitive advantage over red squirrels in mixed woodlands, even where the proportion of conifers is quite high – 75% or more – and this probably relates to their relative efficiency in dealing with different food items. Our red squirrels are clinging to what we provide in the way of suitable primary habitat, particularly large blocks of mature Scots pine woodland, but also other suitable conifer plantations. Such woodlands predominate in upland areas of northern and western Britain, and here red squirrels are still common.

What of the future? Habitat holds the key, and the predominance of either species will depend upon what is provided in the form of suitable woodlands. This in turn depends to some extent on national policy towards timber production and amenity planting, and on the whims of the general public towards what they demand in the way of timber and paper products.

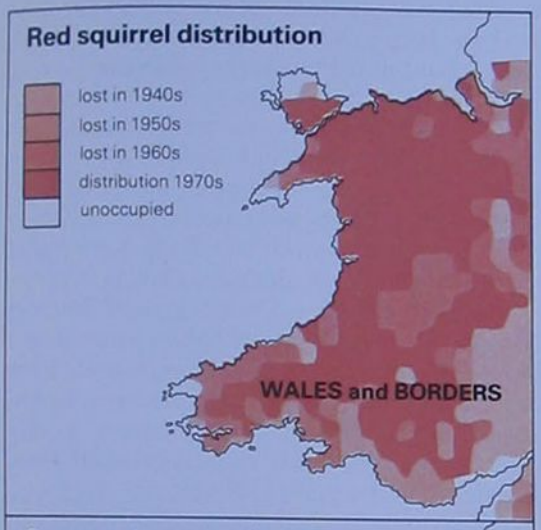
Grey squirrels are gradually penetrating even into some of the red squirrels' primary conifer forest strongholds – in places like Thetford Chase, along the 'amenity' strips of deciduous trees planted in response to public pressure to cover up 'monotonous' conifer blocks. The trend is towards replacement of lowland conifers with broadleaved trees; on the other hand certain deciduous species are being planted less because of their vulnerability to grey squirrel damage. The future of grey squirrels in lowland Britain is secure while present planting policies continue.

Large continuous blocks of mature Scots pine woodland in some lowland areas are at present maintaining viable 'islands' of red squirrels surrounded by 'seas' of grey squirrels, but as these plantations reach their economic life-span many will be clear felled and replaced by broadleaved trees, sometimes under a conifer nurse crop. The short-term outlook for red squirrels is thus bleak in these lowland situations.

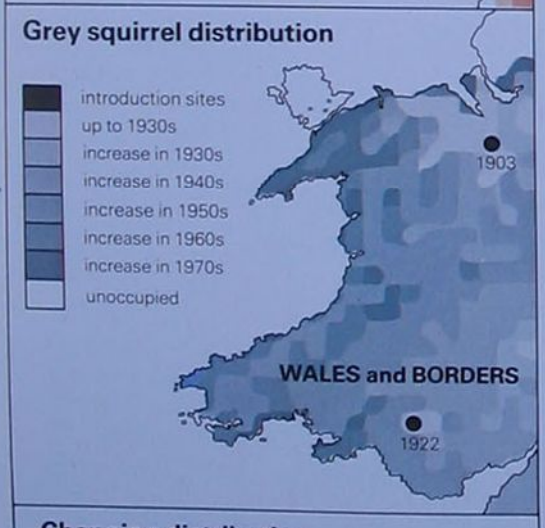
Other non-native conifers, such as Corsican and maritime pines, larches and Douglas fir, have their part to play, but their comparatively small, unreliable seed crop means that an alternative food supply is usually needed nearby. Norway spruce is a satisfactory species, though somewhat slow to mature. Extensive early 20th century planting of introduced conifers have allowed red squirrels to expand into new areas, but the trees will reach their life-span towards the end of this century and are likely to be replaced in upland Britain by faster-growing North American lodgepole pine and Sitka spruce. Early indications are that lodgepole pine is only suitable for occasional summer feeding, whereas Sitka spruce, though not ideal, is more useful for both feeding and residential habitat.

Squirrel control Both species can cause

Left: Within a timber-producing forest a red squirrel is caught in a baited cage trap. Red squirrels are now protected, except under licence to prevent serious damage to crops and growing timber.



Below left: Squirrel distribution changes based on 10km ($6\frac{1}{4}$ miles) grid square surveys. Red squirrels have declined since the 1930s, but they should remain in upland conifer plantations and in some areas both species have co-existed in close proximity for 30-40 years. Grey squirrels have gained ground since the 1930s. They originated here from two successful introductions in Wales and from expanding English populations, which joined up in the 1950s. Apart from Anglesey, there is little suitable ground remaining to be colonized in the 1980s.

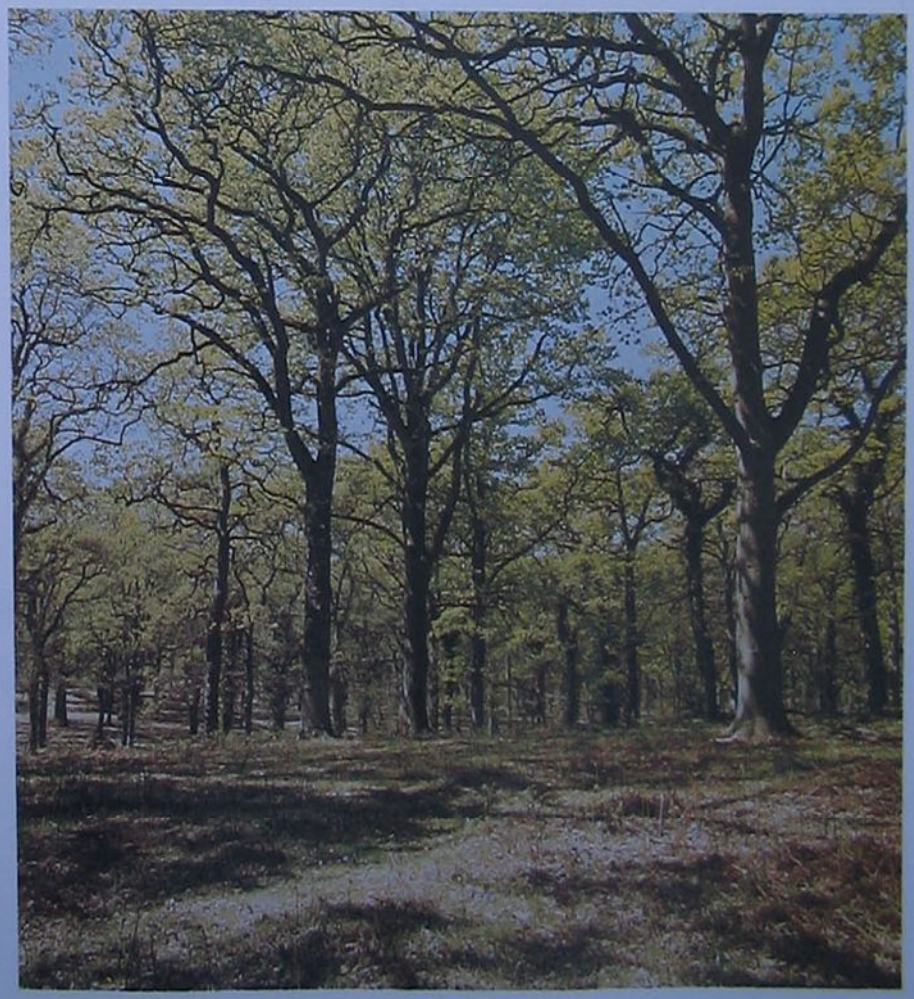


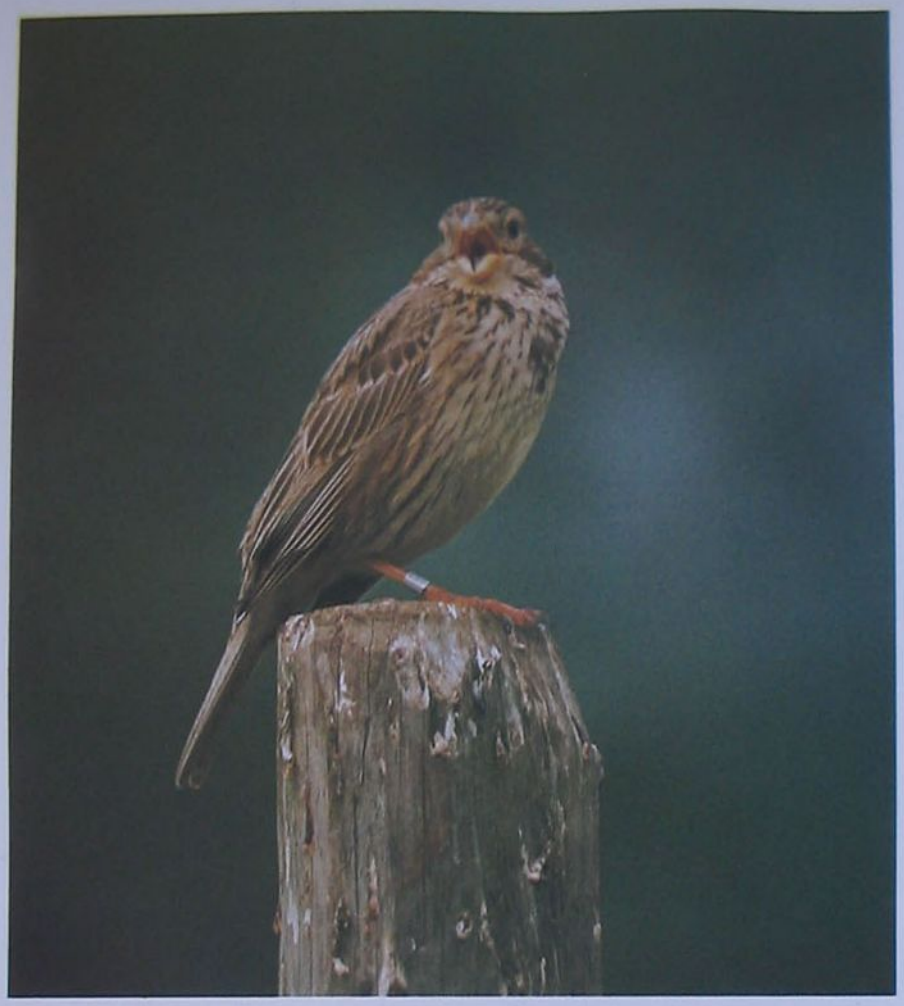
Below: Oak trees in the New Forest. Grey squirrels have adapted rapidly to mature mixed-deciduous woodland, especially those with oaks.

forestry damage by bark stripping, removing leading shoots on young trees, and eating cones in seed orchards; and agricultural damage by feeding on cereals in ear, orchard and soft fruit crops, and bulb crops. They can also be a nuisance to game interests, gardeners and householders. The most widespread problem is the stripping of bark to reach the sappy tissue below, common when other food is scarce. Bacteria and fungi infect the resulting wounds and weaken the trunk at the sites of damage, making the timber unsuitable for marketing except as poor quality pulpwood.

Traditional control is by shooting, drey-poking, spring trapping and baited cage trapping. These are labour intensive, and poison-baited hoppers are now used in areas where the red squirrel is not at risk.

We now know enough about the ecology of the two species to manipulate their environment for their long-term management, either for control or conservation. To control squirrels the habitat is made less suitable, so discouraging either species; to conserve them means providing favoured woodland habitat which is to the advantage of either species. To conserve red squirrels in particular we must plant large, stable areas of their preferred coniferous woodland and provide a continuous succession of mature trees. Protective legislation on its own, however well-intentioned, will do little to help them, except to draw our attention to their plight.





CORN BUNTINGS: FARM RESIDENTS

The sturdy corn bunting is the least colourful of the buntings–you might easily mistake this mottled brown farmland bird for a rather large female sparrow. What fascinates birdwatchers about it is that it occasionally becomes polygamous.

In flight, the corn bunting looks like a large, bulky female house sparrow, being generally brownish above and off-white below. However, a view of a perched individual shows a rather more streaked appearance, each feather having a dark mark down its centre, so that overall the plumage resembles that of a lark or a thrush more closely than that of a sparrow.

If you look closely at an adult corn bunting, you can see that the streaks on the breast form a 'necklace' or 'bib' which outlines an otherwise unstreaked throat and chin. Juveniles, however, until they moult in autumn, have rather more diffuse streaks in this area. The corn bunting lacks the white outer tail feathers which are a useful identification feature of other buntings, such as the reed bunting and yellowhammer. Also, the sexes have identical plumage, though the male may be slightly larger than his mate.

The corn bunting is aptly named, since cornfields are its favourite habitat. In winter you can find it in large flocks on stubble and ploughed land or among field vegetables, often mixing freely with finches, larks and sparrows. In summer, too, it feeds in similar places, though in smaller groups.

Finding a mate For male corn buntings, the breeding season starts early, for they must lay claim to a good nesting territory within a few hundred yards of the feeding area. To do this, they leave the main flock for part of the day, perhaps even as early as late January, though more usually in February or March, to sing in their chosen territories.

Within his territory, each male usually has several song-posts which double as lookout posts. Almost any prominent perch will do: bushes, fence posts, telegraph wires or simply a tall plant such as a thistle. Each is defended vigorously from neighbouring rivals.

Females remain in the flock until April or May before seeking out suitable places to rear their families. They choose a nesting site from among those already secured by the males. Usually it is late May or June before nesting really starts, and most eggs are laid in June, July and the beginning of August.

Above: The corn bunting's song is a short sequence of ticking notes, gaining speed and ending in a flourish, just like the jingling of a bunch of keys. From earliest spring to mid-August the song helps you to find this bird in the field.

Right: The nest is not easy to find, for it is hidden among grass, gorse and brambles. Sometimes it is in a hollow in the ground inside a corn field, at the base of a prominent weed such as a thistle.

Whether a female corn bunting is attracted by a particular male, his song or his territory, is not known; what seems more certain is that the average male is not very particular in choosing his mate. Indeed, a single male may often acquire more than one mate.

Many mates Polygamy in corn buntings was first proved in a detailed study carried out in Cornwall in the 1930s. In one year there seemed to be three or four times as many females as males, and all of the 15 males studied were polygamous. The record was held by one male in an isolated territory who owned an astonishing total of seven females. This particular male, with seven mates, had up to 20 eggs being incubated at any one time, and while at times he seemed to the observers to be quite bewildered by his harem, a total of perhaps 22 young fledged from his territory – a remarkable achievement.

Research shows that in other years there is far less polygamy among corn buntings. Although in some years there are fewer males than females, in others the numbers are more equal. The polygamy may well arise from a shortage of males, but the cause of this imbalance is not clearly understood.

Young fledglings The normal clutch has three, four or five eggs, laid on consecutive days. These the female incubates alone for about 12 days. Since her mate does not feed her, she has to leave the nest at intervals to find food; on average she might spend an hour incubating, followed by half an hour feeding. Thus the eggs are left unprotected for quite long periods, and are therefore well camouflaged, being brown with darker blotches.

The chicks grow rapidly and, unlike most small birds, they leave the nest before they can fly properly. Some flutter off into surrounding vegetation after only nine days, presumably reducing the chance of the whole brood being found and eaten by a weasel or other predator. Certainly they remain dependent on their mother for a further week or two – every few minutes she returns with a grub or insect for the hungriest and noisiest fledgling.

Winter flocking Corn buntings do not migrate, though they do disperse into the surrounding land during the winter. The end of the breeding season marks a new phase in their year. The males stop singing and a new flocking call, sounding like 'tip-a-tip', is frequently uttered in flight. Territoriality ceases, and they become positively gregarious; so strong is the flocking instinct that some males desert their territories even before the last of their young have safely flown. Throughout the autumn and winter, weed seeds form their basic diet.

At this time, corn buntings sleep in communal roosts where they are safer from predators – in a reedbed, for example. Often these roosts are shared with other species such as reed buntings, and each year the same site may be used by hundreds of birds. Towards evening, small groups arrive and perch in trees surrounding the site of the communal roost until, when it is dark enough to move without being seen, they descend to the reeds for the night.

Farmland distribution Corn buntings are known to have bred in virtually every county in the British Isles. However, many areas are now completely devoid of them. Much of this pattern can be explained by their dependence on lowland arable farming. Thus the moors and mountains have understandably sparse populations. But there are gaps in the arable areas today, compared with last century. It is most likely that these are caused by changes in climate, agricultural practice and food availability.

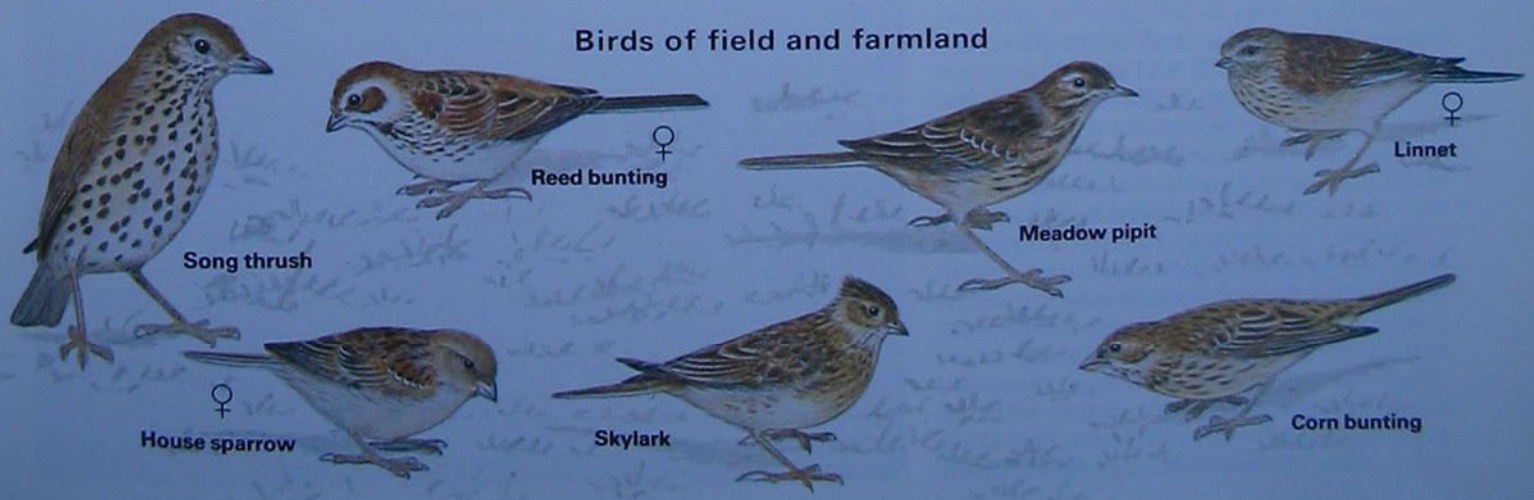
Above: Although a natural bird of arable farmland, the corn bunting is in decline in parts of the cereal growing regions of East Anglia, Kent and Sussex; it is also scarce in South Wales, the Midlands and the lowlands round the Irish coast. This decline is not fully understood but is thought to result from both climatic and agricultural change.

Above right: The corn bunting is so unremarkable in size, shape and colour that some people describe it unflatteringly as a 'little brown bird'.

Corn bunting (*Emberiza calandra*). Resident; breeds and winters in farmland. Sexes are alike except females are slightly smaller. Length: males 18cm (7in).

Below: Several other birds share the farmland habitats with the corn bunting and six of these resemble it quite closely.

Birds of field and farmland



SHRUBBY SEA BUCKTHORN

Confined mostly to the coast, our native sea buckthorn is an attractive orange-berried shrub widely planted to help stabilise shifting sand dunes.

The sea buckthorn, a small attractive shrub, is found growing in the wild around the coast of Britain. It is native to this country and is most common on the east coast, from southern Scotland southwards, and west along the south coast as far as Sussex, though it has been planted widely elsewhere in Britain.

Despite its common name, it bears no botanical relationship to the other British buckthorns, the common or purging buckthorn and the alder buckthorn, just as these two shrubs are also quite unrelated to each other. They have similar names purely because they are all thorny shrubs with unpleasant-tasting berries. The sea buckthorn belongs to the oleaster family, a small group of woody plants.

Shrub or tree Recognising the sea buckthorn is not always easy because it has such a variable habit of growth. It can become a modest-sized tree though it is more often found as a low, much-branched shrub and, in very exposed coastal sites, it may be growing almost horizontally from the effect of the wind.

In other parts of the world, however, the sea buckthorn can be seen as a fairly large tree. In parts of China, for example, specimens up to 20m (65ft) have been found. There and elsewhere in the world, the sea buckthorn grows inland, which may seem strange when you consider that in Britain it is a coastal species. In fact, the sea buckthorn is capable of thriving in a variety of habitats – such as gravels, mountainous steppes and river floodplains – that have harsh conditions and therefore few competing species of shrubs.

Identification The sea buckthorn is a deciduous shrub or small tree, rather willow-like in appearance and growing to a maximum height in Britain of 12m (40ft). This is exceptional, however, and it is much more common as a shrub up to about 4m (13ft) tall.

The bark is grey-brown, becoming fissured and scaly on older trees. Young branches are covered with silvery-grey scales, a feature that is shared by the leaves and is one of the most distinctive characteristics of this species. The branches lose their scales as they grow older. The ends of the smaller branches and twigs

Above: The narrow leaves and bright fruits of the sea buckthorn are quite different from those of other British buckthorns.

Sea buckthorn (*Hippophae rhamnoides*). Native deciduous shrub or small tree, usually growing to a height of 4m (13ft), though it may reach 12m (40ft).

Below: A sea buckthorn in winter. The suckers at the base are characteristic of the species and an important means of reproduction.

bear sharp woody thorns.

The leaves are arranged alternately on the twigs. They are borne on extremely short stalks and are narrow (up to 6cm/2½in long by 1cm/½in wide), tapering at each end. Both surfaces of the leaf are covered with silvery-grey to reddish scales, though they are denser on the undersides. If you examine these scales with a hand lens, you will see that they are rounded with a short central stalk.

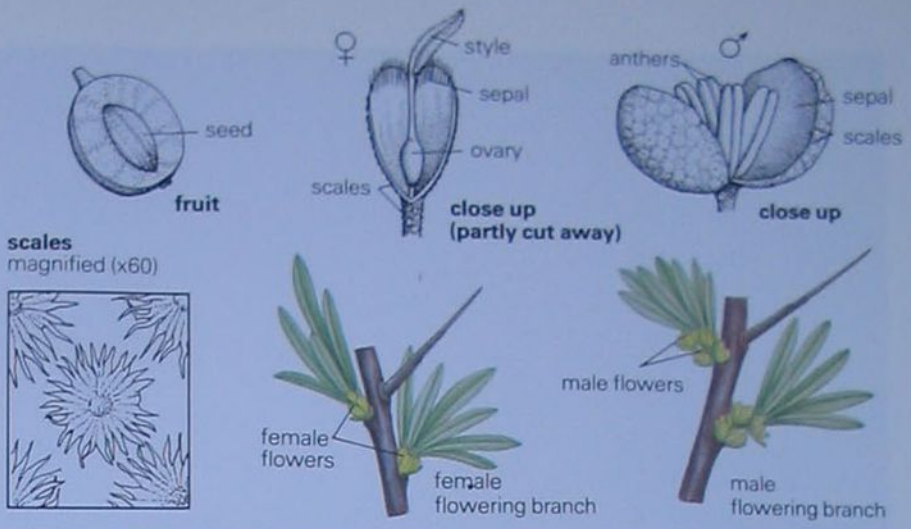
Flowers and fruits The flowers of the sea buckthorn are small and rather inconspicuous, appearing in March or April (before the leaves emerge) in small clusters on the branches of the previous year's growth.

Each plant is unisexual, that is, it bears either male or female flowers but not both. Neither flower has petals. The male is spherical and consists of just two sepals surrounding four small anthers. The female flower has an elongated receptacle with two fused sepals and a single protruding style. Both the male and the female flowers are pale greenish-yellow from the colour of their sepals.

After fertilisation the receptacle swells to form a fleshy layer around the developing single seed. The fruits begin to ripen in September, becoming spherical or slightly egg-shaped, and are about 1cm (½in) across. They, too, bear the distinctive stalked scales of the leaves and young branches. By the time they have ripened they are an attractive orange colour and remain on the plant through the winter until February. The berries have an unpleasantly sharp taste and are not eaten by birds.

As well as reproducing sexually, established sea buckthorn also spreads vegetatively by means of numerous suckers that appear from the base of the trunk.

Sand dune stabilisers The sea buckthorn has several practical uses. Being one of just a small number of shrubs that tolerate salt and so are capable of living on windswept coasts, it has been planted to stabilise sand dunes. On the exposed shifting surface of a dune the roots of sea buckthorn bind the sand together, while its aerial parts reduce the eroding action of the wind, both actions allowing a more permanent, stable soil to accumulate, which can then be put to commercial use. The planting of sea buckthorn also prevents sand dunes from drifting on to neighbouring and perhaps valuable land.



Above: The fruits of the sea buckthorn mature in September to become a bright orange. They then remain on the plant until late winter.

Below: Sea buckthorn is native to the east coast of Britain, from southern Scotland down to Kent and into Sussex. This specimen is growing in Norfolk.

When there is a large enough tree available the wood of a sea buckthorn is much valued by craftsmen. The timber is both hard and very fine grained, which makes it highly suitable for turning. Usually, however, the amount of timber obtainable from the more shrubby specimens is too small to be of use.

The fruits also have their uses and, apparently, are gathered in parts of Europe to make into a jelly or sauce as an accompaniment to fish dishes. This seems surprising when it is considered how unpalatable the raw fruits are.

Garden favourite Besides its commercial uses, the sea buckthorn is also one of our most ornamental shrubs, and most people in this country are more likely to see it growing in a garden than in the wild. Its berries are often borne in dense clusters, providing a bright splash of colour throughout the autumn and much of the winter, whether planted in a shrubbery, as a standard tree or as a hedge. As a hedge it is much planted by farmers, along with other thorny shrubs such as hawthorn or sloe, as a barrier to livestock.

SCRUBLAND'S VARIED BIRD COMMUNITIES

Few habitats are more misunderstood than scrubland. To the farmer scrub is land to be brought into productive use; to the town-dweller it is an unkempt wilderness. But scrub is in fact the term used for the varied bushy habitats which develop naturally on most grassland landscapes if left alone.

The scrubland areas in Britain reveal a great variety of vegetation, which is dependent on the underlying geology and drainage of the area. Wet peaty places are likely to develop a covering of alder and birch scrub–trees unlikely to grow to any great size no matter how long the area is left undisturbed. On drier land sycamore and birch are often the first trees to grow, but they may eventually give way to regenerating forest trees such as oak and beech. In downland areas the main bush is hawthorn which, in the absence of heavy grazing pressure from domestic stock or rabbits, forms dense thickets up to 10m (33ft) high. An important, though transitory, source of scrub comes through planting for forestry since forestry plantations for the first few years of their life harbour a respectable population of scrubland birds.

What is so important about this habitat is,

Above: Chalk scrubland in May–the richness of this type of habitat can be seen in the variety of shrubby plants visible here: ash, field maple, whitebeam and privet are just some of them. Scrub like this can spring up amazingly quickly when grazing livestock and rabbits are not nibbling at all the small shoots and saplings the moment they appear. In time, scrub species give way to larger trees, often oak, until a mature woodland develops. At all stages in this process, birds come to feed on the weed seeds, hawthorn berries and insects found in scrub. Many species of birds–the thrushes, the finches and the warblers in particular–prefer scrub to mature woodland for feeding.

indeed, the wide variety of bird species able to exist in it. Many of them are only rarely found in farmland habitats, while others are regular hedgerow species. Others still, typically birds of woodland edges or clearings, may actually prefer the wider areas presented to them by scrub.

Of course, scrub also harbours a rich community of plants and insects, with interesting perennial plant species able to establish themselves – something that is impossible for them in regularly disturbed cultivated areas or in woodland where tall trees cut out the light from the ground. The insects greatly benefit from the species diversity among the plants, and scrub can be the best area for butterfly watching – particularly for different species and ease of seeing them. In many areas scrub with established grassland, generally present either through deliberate management, grazing pressure or the poorness of soil, may harbour a variety of orchids as well as such species as violets, cowslips and primroses.

Scrubland birds Scrubland can best be defined as an area of ground with a more or less scattered covering of bushes and young trees. Open ground may develop into scrub over as short a time as two or three years if the shrubs involved are fast-growing – in a wet site willows and alder may reach 3m (10ft) in that time. In a harsh upland environment, on the other hand, seed dispersal may take a long time and scrub may only be able to develop in sheltered spots over a period of some decades. As the habitat develops, however, so the bird community increases in numbers and in diversity.

In south-eastern England the chalk downs have still retained many areas of scrub and, since the demise of the large rabbit population through myxomatosis, many areas have started to bush over. The original grassland would generally only have had two main species of perching birds – the skylark and the meadow pipit. But as soon as a few bushes grow, extra species appear. First (and probably dominant until the canopy comes close to closing) is the tiny willow warbler. Then resident species, such as the wren, dunnock, robin, blackbird, song thrush and yellowhammer, start to breed and, probably, a colony of linnets and even redpolls appear. Additional migrant species, arriving as the bushes grow, include tree pipit, blackcap, garden warbler, whitethroat and lesser whitethroat. Most areas will probably attract a grasshopper warbler, whose 'reeling' song can be heard by younger birdwatchers (it is pitched so high that many older people are unable to hear it) but, unfortunately, red-backed shrikes are now unlikely to colonize new areas for their population has declined drastically.

Above: As the bushes and shrubs of the scrub community develop, such shy, retiring birds as this whitethroat – a migrant – appear, attracted to the cover afforded by brambles and other low-growing, thicket-forming plants.

Below: The hawthorn is a typical member of the scrub community – and where you find hawthorn you are also likely to discover the hawthorn shield bug.

After a few more years further species are added to the breeding spectrum – both from birds associated with heathland, like the long-tailed tit or even stonechat and whinchat, and with woodland, like the blue, great, marsh and willow tits, treecreeper and chiffchaff. Added to these are various finches, magpies, jays, turtle doves and woodpigeons, until a bird community of 30 different breeding species may have become established in an area of as little as 2 hectares (5 acres).

Surrounding land This community is interesting in its own right, but is also important when considered as a component of the immediate local bird life. If the adjacent areas have been taken into agricultural use but still have hedges round the fields the scrubland area may act as a focus for the local birds and enrich a much wider area. Even if this does not happen, or if there are other varied

Above: Where scrubland adjoins heathland you may be lucky enough to catch sight of the elusive little stonechat; like so many birds, this species finds it profitable to hunt for invertebrate prey among the scrubland plants.

natural habitats close-by, the scrub does provide many opportunities for the birdwatcher. The birds are often easy to watch since they are not high in the trees, and the watcher has cover in which to seek concealment.

Often the best way to see the birds, at least in summer, is to find a watering place. Ponds can sometimes be found, even in chalk areas, but wheel-ruts where vehicles have passed through are often used, and some photographers have had splendid results by taking their own 'portable ponds' into the field – a couple of gallons of water and a sheet of dark polythene. These work best if positioned and filled for a few days before watching starts.

Urban scrub Scrub areas in urban habitats are often the very best places for the town-tied birdwatcher. Even in city centres derelict plots of industrial land – or building rubble – may quickly develop into varied scrub and attract bird species that would not normally be found in city centres. Many of the industrial areas awaiting redevelopment can provide good birdwatching opportunities, but are often rather difficult of access. Projects like the Breeding Bird Atlas (run from 1968–72 by the British Trust for Ornithology) forced birdwatchers to try to find all the species that were breeding locally and so dragged them away from their traditional reservoirs and sewage farms. Often they were astonished to find that derelict land, quite close to their homes, harboured breeding populations of species they normally thought could only be found miles away.

Conservation of habitat The problem of scrubland being disliked because it looks 'untidy' is one that will take years of education to alter. In many cases the sites owned by large companies and public corporations have become scrubland and these are at the greatest risk of 'improvement'. Land in sewage works, water works, railway sidings, council dumps and so on provides splendid opportunities for birdwatching, but may be bulldozed flat on a later visit. It is, however, sometimes possible for a group of local birdwatchers to take over the management of such areas on a temporary basis, and actively improve them from the birds' point of view.

For example, a wet meadowland area that has been used for grazing horses may start to become scrubland within a couple of years of the departure of the horses. It is very easy to help nature in its development by planting willow cuttings – easily done, for any broken twigs poked into the ground are likely to grow. The willows are so fast-growing that they can quickly get out of hand, so it is a good idea to keep them trimmed and under control.

Modern conservation problems are becoming increasingly focused on the impoverishment of farmland habitats. One means of redressing the balance is to co-operate with the farmers and offer advice on how to use unproductive land to the best advantage for the birds. Advice to this end comes both from the NCC and the voluntary organisations (RSPB and NT – through the Farming and Wildlife Advisory Groups), but practical work can be rewarding and may be undertaken by individuals and informal groups. Some farmers fear that suggested planting schemes for small patches of land in field corners may lead to vast copses of trees that shade the crop and shed branches to be caught in the combine. Having a person helping to control such areas may allay such fears.

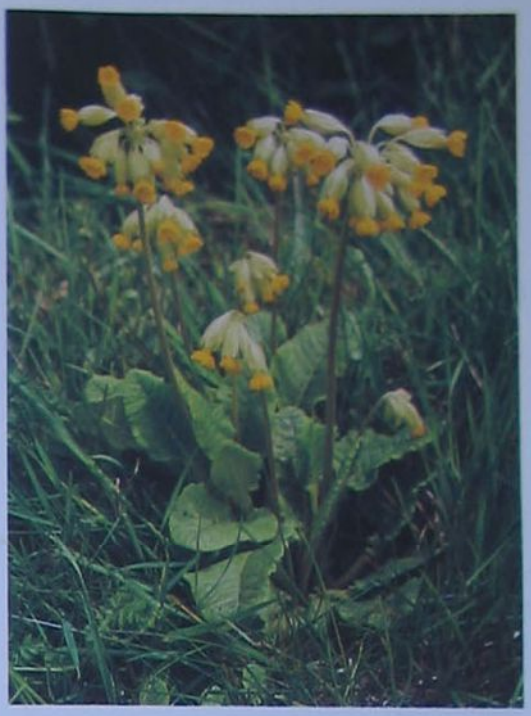
Below: The tiny willow warbler – a long-distance migrant absent from Britain between September and March – is one of the first bird colonists to appear as soon as grassland, left to itself, starts to bush over. Common resident species such as the wren, robin, song thrush, dunnock and blackbird will not be far behind.

Wintering and migratory birds So far we have described mainly the summer scrubland bird communities, but birds also use the sites in winter. Probably the most characteristic are the fieldfares and redwings – thrush migrants from Scandinavia – which are likely to be found feeding on hawthorn berries. Many species use scrub as a roosting site, often in mixed flocks. Probably the most likely rarity to be seen is the great grey shrike (like the redwing and the fieldfare a migrant from Scandinavia), which may sometimes be found in the same area year after year. These grey, black and white birds are a little bigger than a

blackbird and feed on small birds, mammals and large insects.

Probably the most exciting time of year in scrub for birds is the autumn – particularly late August and September. This is the time of year when many migrant species are passing through. On migration such species as whinchat, redstart and pied flycatcher prefer scrubland for feeding and roosting, and can be seen in southern England well away from their normal breeding haunts. Even such rare species as barred warbler, wryneck, icterine warbler and bluethroat may be seen. They are particularly likely to occur along the east coast of Britain, but have been spotted in many inland counties. The seeds and berries offered by scrubland are a vital source of food for the birds – both the residents and the winter visitors – that face the hazards of a British winter. For insect-eating birds, of course, the finding of food is more difficult, but overwintering insect larvae, pupae, and even adults can be discovered in cracks and crannies in the bark of trees.

Right: Among the first plant species to benefit from the cessation of sheep and rabbit grazing on downland are the typical flowers of the chalk – such as the cowslip shown here.



Below: Young whitebeams growing on the scrubby slopes of the Chilterns – once trees like these gain a foothold the development of scrubland is rapid. In some areas it is even possible to encourage the growth of scrub (and thus create havens for our wild birds) by planting such fast-growing plants as willow.

NATURE'S TIME KEEPERS

If you want to know the time, consult one of nature's own clocks – plants whose flowers, or sometimes leaves, open and close with the time of day.

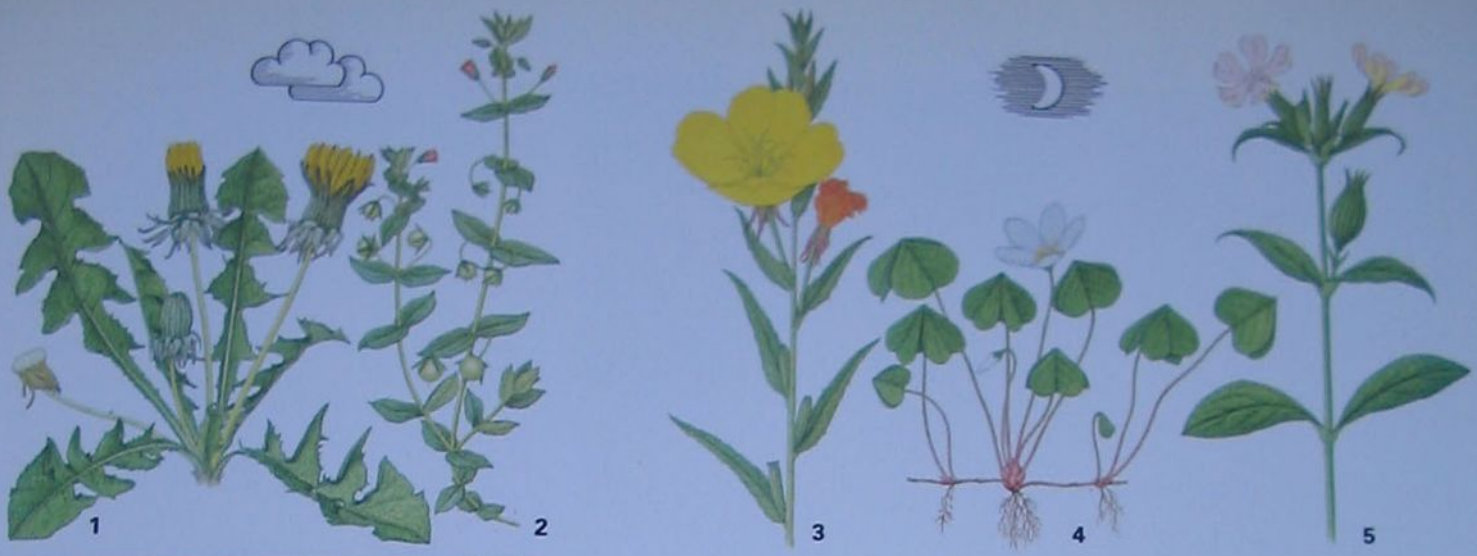
As the earth spins round on its own axis it sets up a rhythmic cycle of day and night. This cycle has obvious effects on the animal kingdom; for example there is our own natural inclination to be active by day and asleep by night, though many other species adopt the opposite role. The response of plants to this regular rhythm, however, though less conspicuous than that of animals, is none the less present in a great many species.

This response of plants can take a multitude of different forms, of which the most familiar is the daily movement of leaves and flowers. Some of these movements are so marked, and occur at such precise times each day, that the plants exhibiting them are often known as clock plants.

The comparison with clocks is apt since some daily movements of plants are regulated by inbuilt time-keeping mechanisms, though others are direct responses to changes in the plant's environment.

Nature's clocks How these inbuilt clocks work is still not fully understood, even after a century or more of research. The leaves of wood sorrel or runner and French beans fold up at night, and it can be shown experimentally that they will continue to do so for several days when the plant is kept in continuous light or continuous dark. However, if they are kept hidden from the natural cycle of day

Above and right: Many plants in the Compositae family open and close their flower heads according to the time of day or the weather. The daisy (*Bellis perennis*) is one of the most familiar examples, opening early in the morning (right), then closing in the evening and also during dull weather (above).
This regular pattern of opening and closing is reflected in the word daisy, which is a corruption of day's eye.



Above: Some plants respond to dull weather, for example, (**1**) dandelion (*Taraxacum officinale*) and (**2**) scarlet pimpernel (*Anagallis arvensis*), which both close up their flowers when the sun disappears. Others respond to the night. The flowers of both (**3**) evening primrose (*Oenothera biennis*) and (**5**) night-flowering campion (*Silene noctiflora*) open at night, whereas the leaves of (**4**) wood sorrel (*Oxalis acetosella*) close up at this time.

Left: The orange-red flowers of scarlet pimpernel appear for just a few hours each day between early morning and the middle of the afternoon. Even then, they quickly close up if the sun disappears.

and night for long enough, their time-keeping ability breaks down and the opening and closing of the leaves becomes irregular or ceases altogether. So it would seem that for a plant's inbuilt clock to keep time accurately, it needs the regular signals provided by day and night.

Precisely why the leaves of some plants close up at night is difficult to determine. Such movements are often called 'sleep movements', but there is no evidence of real sleep in plants. In most cases the sleep movements seem to be the plant's way of minimising the amount of heat lost through the leaves during cold nights. The movements are caused by changes in the water content of special cells in the leaf-stalks. During the day the cells are full of water and the stalks are held upright, but at night the cells lose their water and the stalks become limp.

Flower opening times A much more familiar phenomenon to most people is the opening and closing of flowers at different times of the day. This is usually a response to certain weather conditions – usually temperature, humidity and the level of light; since these conditions normally change through the day the flowers follow a regular pattern of movements.

The opening and closing of flowers can serve one of several functions, though it is often difficult to determine which is the most important in any particular instance. Some flowers close at night to protect their delicate reproductive parts from the cold, while others – including dandelion, scarlet pimpernel and goat's-beard – close in dull weather. One probable explanation for closing in dull weather, apart from the flower protecting itself from the cold, is the danger of rain washing the pollen away.

In other plants, the opening and closing of flowers is associated with pollination. Many flowers open and release most of their pollen to coincide with the time of day when particular types of pollinating insect are most active. This has the advantage of increasing the likelihood of the favoured type of insect visiting the flower and pollinating it, while at the same time reducing the possibility of visits from un-

Above: Flowers of lesser celandine (*Ranunculus ficaria*) open on a sunny day ready for visiting pollinating insects. If the sun were to go in, the flowers would close up to protect the pollen from the cold and rain. The greater celandine remains unaffected by the sun's disappearances, though this is less surprising when you consider that the two species belong to quite different families.

Left: The flowers of goat's-beard (*Tragopogon pratensis*) open very early in the morning and then close up by noon. During the afternoon a clump of goat's-beard growing among grasses can seem to have disappeared.

suitable insects – those that cannot be relied upon to pollinate the flower correctly.

The mulleins, for example, shed most of their pollen between about six and ten o'clock in the morning, which is the peak time of day for bees to visit flowers. They continue to shed smaller amounts of pollen until five o'clock in the afternoon, and indeed a few bees are likely to pay a call until then.

The night shift Another group of plants keeps its flowers closed or scentless during the day and becomes attractive only at night when moths are on the wing. The evening primroses open and become sweetly scented in the evening, as their common name implies. Night-flowering campion has petals that roll inwards during the day to cover the mouth of the corolla tube, but at night the petals spread open and the flowers become strongly scented to attract moths. On the other hand, the flowers of night-scented stock remain open day and night yet, as the name suggests, their scent is released only when it is dark.

Time-keeping names The distinctive flower movements of many plants are reflected in their names. Three of our most common clock plants, goat's-beard, scarlet pimpernel and star of Bethlehem, are all alternatively known as Jack-go-to-bed-at-noon (or John-go-to-bed-at-noon) because they all close up their flowers towards mid-day.

Other names, such as nap-at-noon and sleepy-head for goat's-beard and eleven o'clock lady, morning star and sleepy Dick for star of Bethlehem, originated in the same way.

In some parts of the country, dandelions are known simply as clocks because their flowers open at dawn and close in the late afternoon. This association with time-keeping probably accounts for children using the fruiting heads as clocks – they tell the time by the number of puffs needed to scatter the fruits. The fruiting heads are also popularly known as clocks.

The scarlet pimpernel has some 50 common names, many of which reflect its behaviour as a clock plant. Its flowers open early in the morning when the temperature rises and humidity drops, and then close in mid-afternoon when the air begins to cool and becomes more humid. In cold, damp weather the flowers fail to open, and so common names such as change-of-the-weather, shepherd's weatherglass and weatherflower are all very appropriate.

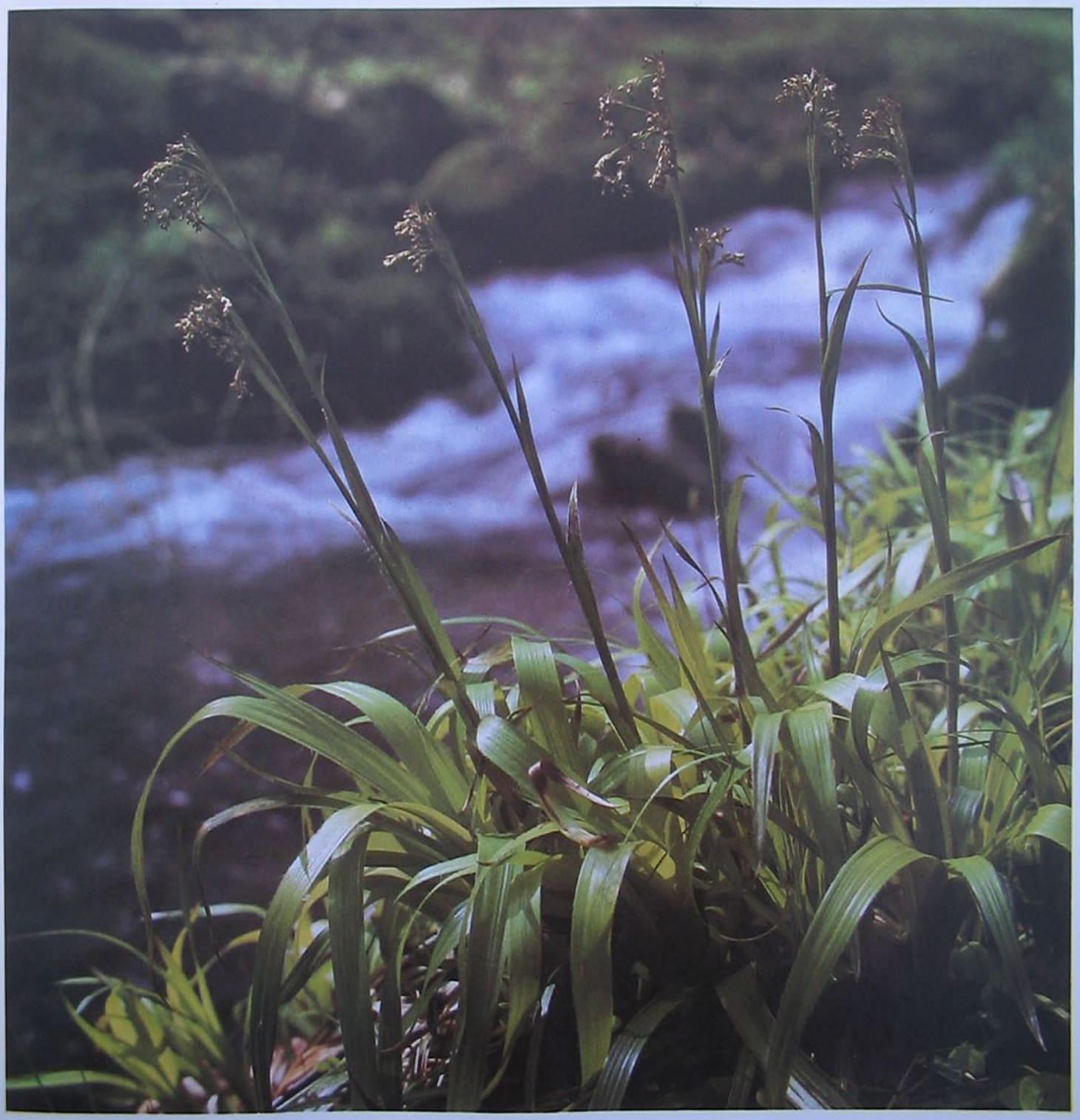
Linnaeus's floral dial The opening and closing of flowers has been known since antiquity and, in the past, has sometimes been put to use. The famous 18th century Swedish botanist, Linnaeus, who devised the system of botanical names still used today, planted a type of floral clock in his garden. He arranged a carefully chosen selection of clock plants in a circle, ordered so that the flowers opened and closed in a sequence that showed him the time of day.

WOODRUSHES OF MANY HABITATS

Hidden away in places as diverse as scree slopes, lowland woods and moorland, woodrushes are rarely as conspicuous as the streamside specimen of greater woodrush shown below – at almost 90cm (3ft) tall, the largest British member of this group.

When you see a woodrush for the first time, it looks very similar to an ordinary rush, though the differences were enough for early country folk to distinguish between them and give them different names. Botanists still recognise the distinction between these two groups of plants, classifying rushes into the genus *Juncus* and woodrushes into the genus *Luzula*.

Rush or woodrush? A close look at the two genera soon reveals some clear differences. First, woodrushes always have hairy leaves while those of rushes are perfectly hairless. Second, the fruit of a woodrush has no internal divisions and contains just three large seeds; that of a rush is divided internally into three compartments, each containing a great



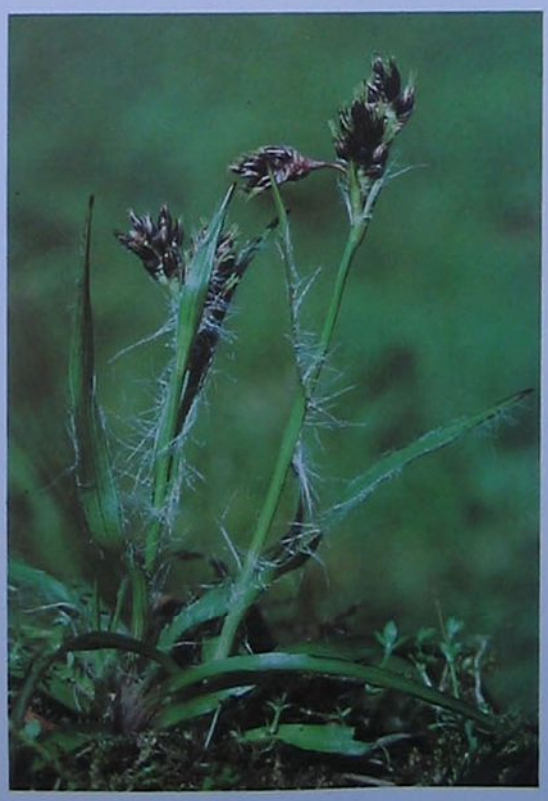
Left: Greater woodrush (*Luzula sylvatica*) belongs to the woodland group of woodrushes, though it also occurs in wet rocky gullies on mountains along with other typical woodland species such as wood anemone, wood sorrel and certain ferns.
Wherever it grows, greater woodrush is always recognisable by its sheer size: its leaves can grow to a height of 80cm (32in) and are rarely shorter than 30cm (12in); in width they can reach 12mm ($\frac{1}{2}$in) or more. Its tepals are dark brown and unequal in size, the inner set of three being slightly longer than the outer set and about the same length as the fruit. The flowers appear in May and June.

Above and right: Our most common species, the field woodrush (*Luzula campestris*) occurs in grassy habitats throughout the British Isles. Also known as sweep's brush, it reaches a height of 15cm (6in) and has short broad leaves. The flower head consists of one stalkless cluster of flowers and between three and six other clusters, all stalked and rounded. Each cluster comprises three to twelve flowers, whose chestnut-brown tepals (which you can see clearly in the above picture) provide a striking contrast to the bright yellow stamens and the green stigma in the middle of the flower. The tepals are all roughly the same length, sharply pointed and longer than the fruit. The flowering period is April and May.

number of tiny seeds.

The flowers of the two groups are too similar to be of any use in identification. Woodrush flowers are rather small – typically around 5mm long – and usually straw-coloured or chestnut-brown. The sepals and petals are very similar to each other and so are known collectively under one term: tepals. Each flower has three outer tepals (equivalent to the sepals of a typical flower) and three inner tepals (equivalent to the petals).

Despite their close relationship and the similarity in their appearance, rushes and woodrushes scarcely compare in terms of their importance to Britain's flora. Whereas the true rushes can be the dominant plant over large areas of marsh or mudflat, woodrushes seldom dominate the vegetation in which they grow – indeed, it is rare to find a woodrush that is at all conspicuous.



The British Isles has ten species of woodrush, of which two are escapes from gardens. The other eight can be conveniently grouped according to the habitat in which they grow.

Woodland woodrushes This group, members of which are found in hedgebanks as well as woodland, comprise the hairy woodrush, Forster's woodrush and the greater woodrush. The first two are quite different from all other species of woodrush because they bear their flowers singly on long fine stalks in a loose head at the tip of the stem. Other woodrushes bear their flowers in groups.

The hairy woodrush is the commoner of the two, being found throughout the British Isles. It grows to a height of 30cm (12in) and its flower stalks spread out stiffly early in the year, later pointing downwards as though the fruit were too heavy for them to support.

Forster's woodrush is less common, being confined to southern England and south Wales northwards to a line about level with Leicestershire. It is a smaller, more slender plant than the hairy woodrush, but otherwise differs mainly in the flower head. On Forster's woodrush the flower stalks are all turned to one side and when the fruit is ripe they droop a little but do not actually point downwards. On both species the tepals are sharply pointed, but on the hairy woodrush they are a dark chestnut-brown and a fraction shorter than the fruits, while on Forster's woodrush the tepals are a little redder and slightly longer than the fruits.

The third member of this group is the greater woodrush. It is a much larger plant than the other two (at least 40cm/16in tall)

and its flowers are borne in groups of three or four (occasionally five).

Woodrushes on mountains This group has two members, neither of which is common. The spiked woodrush is found on heathland and scree slopes on the Outer Hebrides, Shetland and the mountains of mainland Scotland. It is not much more than 20cm (8in) tall and has a most distinctive flower head. Instead of being borne on a long stalk, as is the case in most woodrushes, the flower head is almost completely stalkless on this species.

The curved or arcuate woodrush is much the rarer of the two species, being confined to open, stony ground on just a few mountains in the Cairngorms and the far north and west of Scotland. It is a dwarf plant, no more than 8cm (3in) in height and forms small neat tufts connected by short runners.

Grassland species This group covers woodrushes that are found in grassland, moorland or fens and includes the best known of all our woodrushes–the field woodrush. This species is extremely common in grassy places throughout the British Isles and is the earliest woodrush to come into flower–from March onwards. It is rather variable in form but, typically, is loosely tufted and spreads among the grass by means of short runners that creep over the surface of the ground. It grows to a height of 15cm (6in) and has short broad leaves. A single flower head contains between four and seven clusters, each bearing three to twelve flowers.

A similar species to the field woodrush, but one that grows in quite different places, is the many-flowered woodrush. It too is found throughout the British Isles but prefers the more acid, peaty soils of heaths, moors and sometimes woods. A taller species, growing to a height of 20-40cm (8-16in), it is much more densely tufted and lacks runners between the tufts. The flower head can contain up to ten clusters, each with as many as 16 individual flowers–hence its common name.

The last member of this group, the fen woodrush, is exceedingly rare in this country and is similar to the many-flowered woodrush.

Garden escapes The other two woodrushes found in the British Isles escaped from cultivation. Both are distinguished at once from the native species by their off-white flowers, sometimes tinged with grey, pink or red, which contrast with the chestnut-brown or straw-coloured flowers of our native woodrushes.

The white woodrush is the commoner of the two and has become firmly established in parts of Britain. It usually grows in damp or shady places in woods and by streams, especially on acid soils, and reaches a height of 30-60cm (1-2ft). The snow-white woodrush is very rare in the wild, though popular as a garden plant. Its flowers are pure white, whereas those of the white woodrush are tinged with grey or pink.

Left: Our rarest native woodrush, the fen woodrush (*Luzula pallescens*) is found in just two sites in East Anglia and one in Northern Ireland. It bears small, pale yellow flowers in April and May.

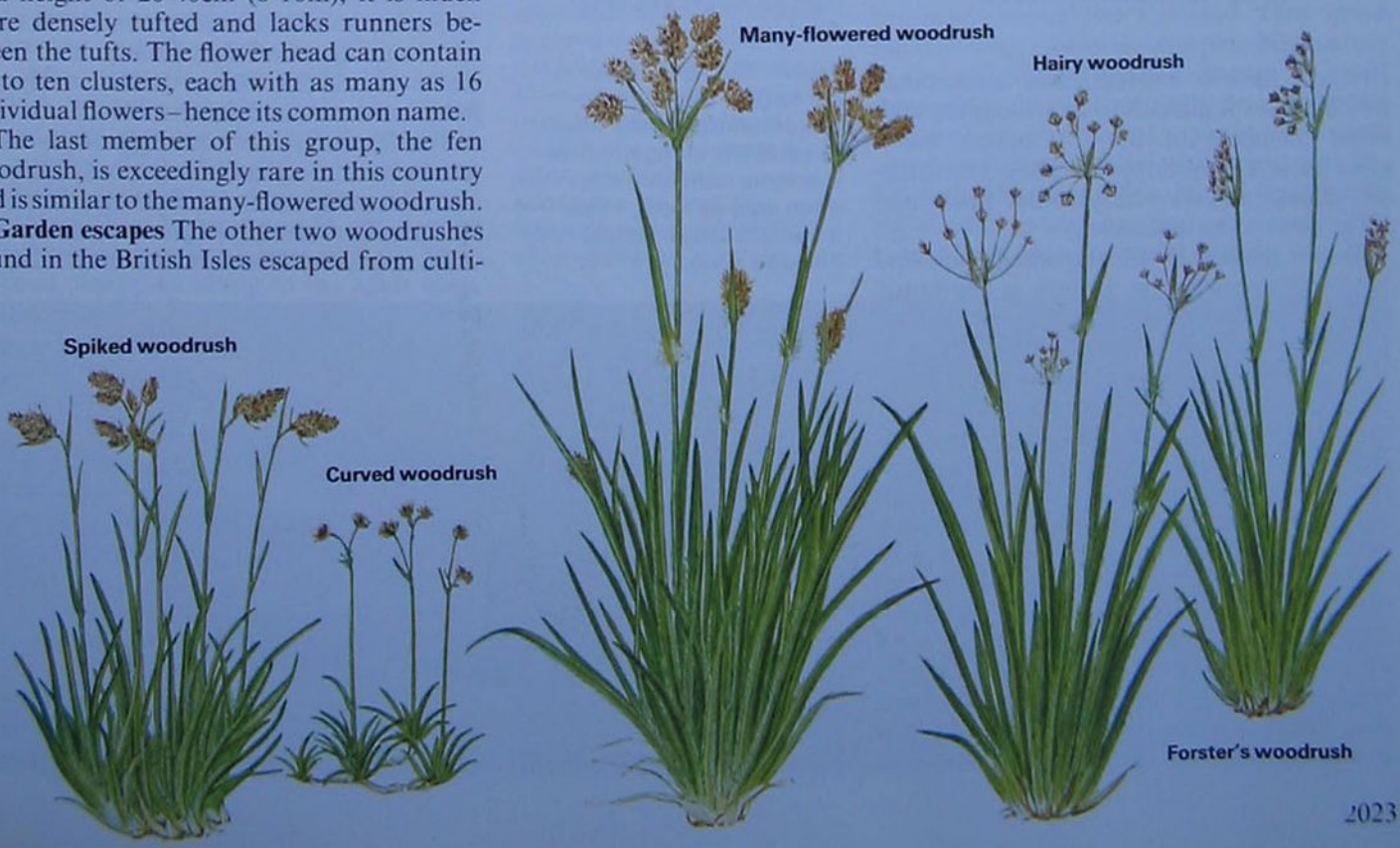
Spiked woodrush (*Luzula spicata*). A mountain species growing to 20cm (8in) high. Flowers in June and July.

Curved woodrush (*Luzula arcuata*). A rare mountain plant, barely 8cm (3in) tall. Flowers June and July.

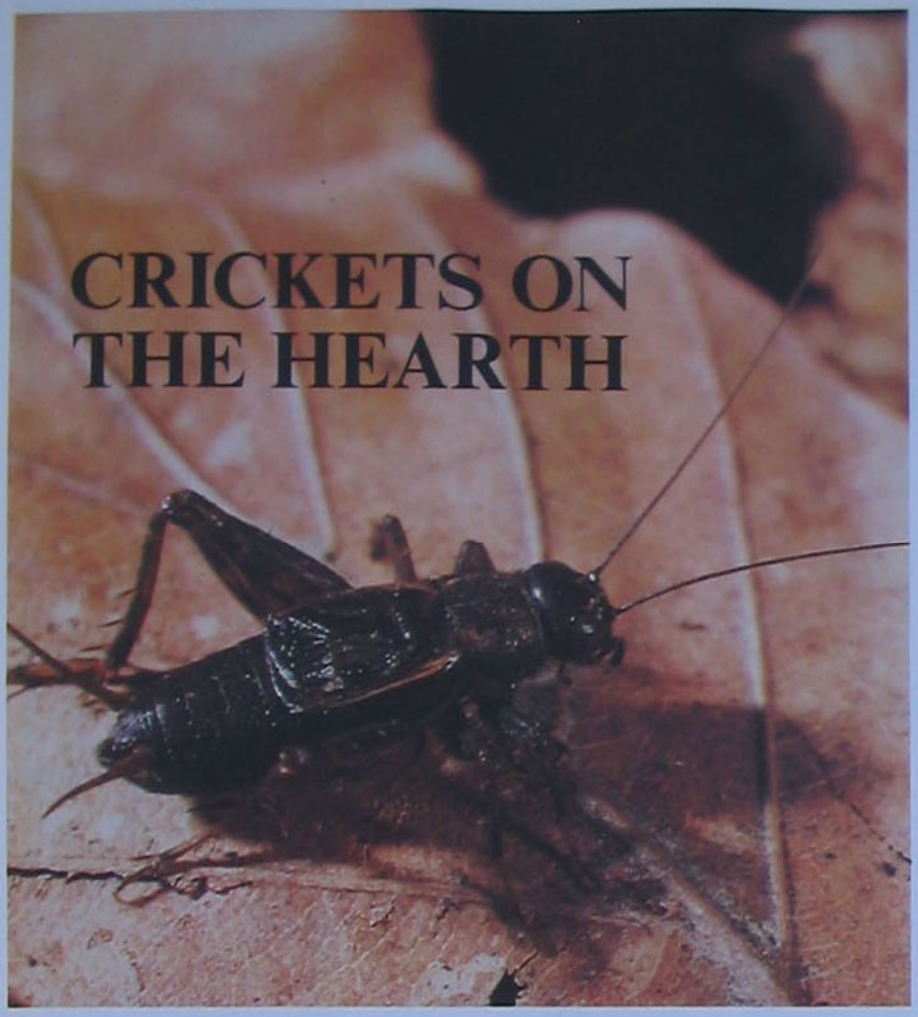
Many-flowered woodrush (*Luzula multiflora*). A tall woodrush, reaching 20-40cm (8-16in), found on acid, peaty soils of moors, heaths and woods. Flowers April to June.

Hairy woodrush (*Luzula pilosa*). A woodland species, growing to 30cm (12in) tall. April to June.

Forster's woodrush (*Luzula forsteri*). Found in southern Britain only. Height 25cm (10in). Flowers April to June.



CRICKETS ON THE HEARTH



If you are in an old house as dusk falls, listen carefully and you may hear the chirping of the house cricket – one of four British species.

Above: Wood crickets are found only in the south-west of England, the Isle of Wight and the New Forest. They live among leaf litter in rides and along the edges of woodland, and feed on plants and small dead insects.

Below: The field cricket is our largest cricket, and has an unusually big head. In southern Europe, where it is more common, it is often sold as a pet, since it has a musical, almost bird-like song.

Crickets have a characteristic appearance which makes it difficult to confuse them with other members of the Orthoptera – bush-crickets and grasshoppers. They are thick-set, chunky insects with globular heads and long, thread-like antennae.

Desert crickets By far the commonest and best known species in Britain is the house cricket, immortalized by Dickens in his Christmas Tale *The Cricket on the Hearth*. It is not a native British insect since it was introduced many years ago from the arid areas of north Africa and south-west Asia. For this reason it is rarely seen outdoors, although recently it has been found on rubbish tips where the heat produced by fermentation creates mild temperatures.

Its normal habitat in this country is indoors in warm crevices, particularly those in kitchens and bakeries. Normally little is seen or heard of the house cricket until dusk, when it emerges from its hiding place to look for food or a mate. It is sometimes active during the day in hot weather, although it avoids sunlight. It feeds on almost anything of plant or animal origin – one reason why rubbish tips are such a suitable habitat.

From their hiding places the males produce a monotonous chirping to attract the females after dark. As in bush-crickets, the sound is produced by a toothed vein on one wing rubbing against the hind margin of the other wing. In crickets the right wing carries the toothed vein and overlaps the left one, while the opposite occurs in bush-crickets. When a female appears the male's stridulation changes to a more subdued courtship song.

The females lay several hundred eggs each (one thousand has been recorded), either singly or in small groups in crevices, using their long ovipositors. The eggs hatch into nymphs after a week in hot conditions, but after as much as two to three months at ordinary room temperature. The nymphs resemble minute wingless crickets without ovipositors – they feed and behave just like adult crickets, except that they do not reproduce.

Before becoming adult the nymphs undergo as many as ten moults, the wings developing as external pads at about the eighth moult, when the females also start to show their ovipositors. The nymphal stages last for one to eight months according to the temperature, and the adults can live for several months. There is no proper resting stage and breeding goes on in suitable conditions throughout the year, although the cycle slows down when it is cold.

Woodland species The wood cricket is a native British insect, found only in the south-west of England, the New Forest and the Isle of Wight. It is dark brown, mottled with paler brown or yellow, and has short fore-wings and no hind wings – it cannot fly. Its song is a quiet churring sound which carries only a few yards and is easy to miss unless you are listening carefully. Unlike the house cricket it is active during the day, moving in jerky runs and short jumps.

The female lays her 200 eggs singly in the soil between July and November. The eggs overwinter and hatch the following June, but the nymphs are only half grown by the winter, when they go into semi-hibernation. They do

not become adults until the following summer, almost two years from the egg stage.

As a result of the long developmental period, wood crickets may be found in two or three stages throughout the year – eggs in the soil (to hatch next year), last year's nymphs on the surface, with the year before's adults. The overall effect is that of a population existing in two strains which become adult in alternate years and probably do not interbreed.

Singing like a bird The largest of our true crickets is the field cricket, a shiny black insect with pale yellow markings at the base of its wings. Its front wings are well developed and almost cover the abdomen in both sexes, but the hind wings are vestigial so it is unable to fly. Nowadays it is a rare insect found only on south-facing grassland and heaths in parts of southern England.

The male's stridulation, loud and shrill, is audible at 100m (330ft) and is musical and bird-like in tone. He sings from his burrow entrance to attract the wandering female who then stays with him, sharing his burrow.

The female lays several hundred eggs near the burrow, inserting each one singly in the soil. After three to four weeks the small blackish nymphs emerge and live above ground until they are almost fully grown in the autumn. They then dig burrows about 20cm (8in) long, using their jaws and hind legs. Here they hibernate until the end of March when they wake up and open their burrows, finally moulting to the adult stage a month later. The adults do not live very long, usually dying off in July.

Subterranean species Although not a true member of the cricket family (Gryllidae), the mole-cricket is closely related to the three species described above. A most unusual looking species, it is very rare now, occurring only in parts of Hampshire and Surrey. Formerly it was also recorded in Wales, Scotland and Ireland.

The mole-cricket is a fairly large, brown insect and has specially modified front legs for digging – hence its common name. Its hind wings are fully developed so that it can fly, albeit in a rather noisy and clumsy fashion. Normally found in moist places, it makes

Cricket round-up

Below: **Field cricket** (*Gryllus campestris*). Length 19-22mm ($\frac{3}{4}$-$\frac{7}{8}$in). South facing grassland, heathland.

Above: **House cricket** (*Acheta domestica*). Length 14-17mm ($\frac{5}{8}$-$\frac{3}{4}$in). Found indoors and on rubbish tips.

Above: **Wood cricket** (*Nemobius sylvestris*). Length 6-10mm ($\frac{1}{4}$-$\frac{1}{3}$in). In rides, woodland edges.

Above: **Mole-cricket** (*Gryllotalpa gryllotalpa*). Length 35-45mm ($1\frac{1}{2}$-$1\frac{3}{4}$in). Rare, occurs Hants, Surrey.

Above left: The curious looking mole-cricket has front legs which are specially adapted for digging. The tibiae and tarsi (clearly visible in the picture) are broad and covered with spines, making them look rather similar to the forelimbs of a mole. The first two segments of the tarsi expand into stout spines which work to and fro across the spines on the tibiae, operating like a pair of shears to cut rootlets.

Below: The house cricket came to the British Isles from north Africa and south-west Asia many years ago. Since it is unable to stand our cold winters it is usually found indoors, although in recent years it has colonized municipal rubbish tips – here there is plenty of food and conditions are also relatively warm as a result of fermentation.

underground burrows, up to a metre deep in dry conditions but shallower in moist soil. In these burrows the mole-cricket runs forwards and backwards extremely fast. It feeds on insect larvae and plant roots, occasionally causing considerable damage to root-crops. The male makes a soft churring sound from inside his burrow entrance which is horn-shaped to concentrate the sound.

In early spring the female lays 1000 to 3000 eggs in a heap on the floor of an underground chamber. She shows a degree of maternal care, guarding her eggs and keeping them moist to protect them from fungi. The eggs hatch in two to four weeks and the young remain with their mother for a few weeks before dispersing above ground. They spend the following winter as nymphs, hibernating in the soil. Each female continues to breed throughout the summer, so the developmental stages of the hibernating nymphs vary, some spending two winters before becoming adults. The total life-span of this species, from hatching to adult, is over two years, making it even longer-lived than the wood cricket.

THE HAWFINCH: A HEAVYWEIGHT FINCH

The hawfinch – a large species of finch – is equipped with a disproportionately large bill which can exert as much power as can a man with a pair of pliers. Cautiously concealing its movements in the foliage of tall trees, it presents a unique challenge to the most patient of birdwatchers.

Below left: A female hawfinch – less colourful than the male – on a low garden wall. The habitat of this species ranges from mature deciduous woodland, which is its commonest haunt, to mixed woodland, large parks, and gardens with trees. Hawfinches can even occupy scrubland areas that have a few trees. In winter and spring they frequent cherry, plum and damson orchards.

Above: Our hawfinch population is estimated at about 10,000 pairs. Most of them are in central and south-east England, where woods with hornbeam trees are plentiful.

Below: The normal hawfinch clutch is of 4-6 eggs, buff or blue in ground colour with various darker blobs and squiggles adorning them. Most clutches are laid in May, and incubated by the female alone for 11-13 days. Both parents feed the youngsters after hatching, and they fledge a fortnight later.

To see the hawfinch, our largest and most spectacular species of finch, is regarded by ornithologists as a considerable achievement. Despite its size, this bird is extremely secretive and normally very quiet, betraying its presence in the neighbourhood only by a series of 'tick' calls – sounding a little like those of the robin.

It feeds both on the ground (where you are most likely to get a chance to see it) and in the trees, but if disturbed on the ground it flies up into dense cover, often being so wary that half an hour may pass before the first individuals drop down from the branches and cautiously begin to feed again.

Stocky outline Slightly smaller than a song thrush, the hawfinch is a stocky bird. In flight it has a characteristic heavy-headed, short-tailed appearance. Its flight path is steeply undulating, with a brief burst of wing-flaps followed by a glide rather like the flight of a woodpecker. Also reminiscent of a woodpecker are the conspicuous broad white wing-bars, clearly visible from above or below. The white flashes on either side of the stumpy tail are very noticeable in flight.

On the ground, the first feature that catches the eye is the enormous head and beak, which seem out of proportion to the rest of the bird. The head is pale chestnut in the male, drab brown in the female – in both cases set off from the rich rufous-brown back by a grey or fawn collar. Both sexes have a black

'mask' round the base of the beak and a large black bib. The massive beak, slightly larger in the male than the female, is silver-grey with black edges and a black tip. Shaped like a triangular pyramid, it may be as much as 18mm (¾in) long, wide and deep.

The belly and flanks are rich buff, and against them the wings appear dark, almost black. A close view reveals that the outer flight feathers are grey-brown, but they are largely concealed by the inner feathers that overlie them. These have a rich purplish sheen and peculiar splayed ends, almost like old-fashioned curled moustaches. They are thought to play a part during courtship display. The white wingbar is clearly visible on the folded wing, shaded with brown or chestnut. The legs are pale yellowish-brown, and the eyes have a most unusual marbled pink iris surrounding the dark pupil, particularly in the male.

Young birds are altogether drabber, with a yellow-washed appearance and speckled slightly on the belly and flanks. After they moult in August and September of their first year, they become difficult to distinguish from the adults.

Calls and songs By far the best way to spot hawfinches regularly is to become familiar with their call. This is the sound the birds make at all times of year for such purposes as maintaining contact or warning of approaching danger.

The hawfinch makes its call both in flight and when perched, so it is advisable to look both up *and* around. Although the call has much in common with that of a robin or song thrush, the 'tick' or 'tchick' is rather more abrupt and clicking than in either of the other two species. A good way of learning to make the distinction without error is to gain access to a recording. Several of these are available through specialist shops or the main ornithological societies such as the RSPB or the British Trust for Ornithology.

The song, however, is an entirely different matter. This sound, usually more musical or attractive than the call, is made at a specific time of year–the breeding season–and its purpose is to advertise territory and attract a mate. There are few, if any, good recordings of the hawfinch song, partly because the birds are so shy and difficult to approach, and partly because it is so quietly uttered. Produced from March to May, it is a hesitant but tuneful jangle, perhaps most reminiscent of the song of the goldfinch.

A widespread bird Despite these difficulties in seeing hawfinches, recent surveys on a county and national scale have shown them to be quite widespread across England and southern Scotland. The major concentrations, perhaps associated with the distribution of one of their favourite foods–hornbeam seeds –are in central and south-east England, while the records fall off rapidly in Wales and the West Country. There are few records from Ireland and none breed there today, though one pair did nest in County Kildare in 1902.

Recent estimates suggest that the population may amount to about 10,000 pairs. From such historical records as there are–mostly associated with hawfinch attacks on cherry crops–it appears that they were restricted to the south-east until the middle of the 19th century, when an expansion phase began to give hawfinches their present-day distribution pattern.

Feeding hawfinches The presence of feeding hawfinches in an orchard is given away in winter by large numbers of neatly split fruit stones on the ground. During the summer, look for shredded pea pods, another favourite food. As with several other finches, insects feature considerably in the diet of the nestlings, but at other times they eat a wide variety of seeds, ripe and unripe, from herbaceous plants, shrubs and trees. Like bullfinches, hawfinches also turn to buds of both wild and orchard trees.

Among the seeds they eat are the kernels of wild and orchard cherries, sloes, damsons and other plums, and beech and hornbeam

A hawfinch secondary or inner-wing flight feather. At the tip, one corner protrudes in a triangle and the other is cut away in a neat curve. The feather has a blue-green sheen.

Hawfinch (*Coccothraustes coccothraustes*). Our largest finch species. Resident in woodland, especially in fruit-growing areas. Length 16.5cm (6½in).

Below: Hawfinches often visit puddles to bathe and drink.

Above: A male hawfinch on the ground. The head is a pale chestnut colour, the collar is grey and the back a rich rufous brown. Here you can see the purplish, splayed inner flight feathers—the four inner primaries and the secondaries. These feathers, the unusual shape of which does not impair flight efficiency, are thought to be used in courtship. No other British bird has splayed feathers like this.

mast. All of these are extracted from very robust shells—and it is here that the formidable beak comes into its own. Not only is the beak huge, but the mouth is equipped with sharp ridges, as are the jaws of a vice, to hold seeds while they are crushed.

One reason that the hawfinch's head is so large is that its jaws are worked by extremely powerful and thus bulky muscles, capable, it has been calculated, of exerting a peak pressure of 200 pounds per square inch. Certainly, any bird ringer handling a hawfinch who is careless enough to let a finger come within reach of that massive beak can testify to a nip at least as painful as catching the finger between a hammer and nail!

A social species Hawfinches display social behaviour at all times of the year—both in and out of the breeding season. Colonies are small groups, loosely scattered over a communal territory of an acre or two. During the winter, particularly in orchards where plenty of fallen fruit from the previous summer has ensured a lasting food supply, they will join with other finches and thrushes to feed on the orchard floor, often in some numbers.

On winter nights there are several reports of large roosts (more than a hundred birds) gathering high in dense trees. This occurs in coniferous trees as their evergreen foliage provides dense cover. One site, for example, is in the Bedgebury Pinetum in Kent, where the roost has frequently contained up to 100 hawfinches.

Such roosts must draw in birds from a considerable area, and it is interesting to speculate on their function. Is it just that these roosts are the best shelter available for miles around, or is there some communal purpose—perhaps to convey in some way the location of good feeding areas?

Apart from movements of a few miles within their home range to feed or roost, ringing recoveries show that hawfinches in the British Isles are relatively sedentary birds compared with their Continental counterparts, which migrate south regularly to escape severe winter weather. There is very little evidence that Continental birds reach our woodland areas for the winter months.

The range of the hawfinch outside the British Isles is fairly extensive. It can be found from North Africa right across Europe, and through central Siberia to Manchuria and Japan. The furthest north it reaches is southern Sweden. Throughout this range its powerful bill allows it to maintain a monopoly of certain food items—cherry and plum kernels, for example—that other finches are unable to utilise. Only the bullfinch—with a bill roughly half as big as that of the hawfinch—can compete at all.

Right: Like some other finches, hawfinches often breed socially—not in densely packed colonies like rooks or herons, but in a scattering of up to half-a-dozen pairs in an acre or two. Whether in a loose colony or singly, the hawfinch pair feeds well away from the nest, thus attracting less attention to the nest and making it harder for predators to locate. The nest itself is like a large version of the bullfinch's nest, with a platform of twigs supporting a shallow cup lined with rootlets and fine grasses. Usually it is built high up, over 3m (10ft) and up to 27m (70ft) above the ground, and often at the end of a long horizontal branch for extra security. Although it is difficult to be certain because of their secretive habits, hawfinches usually seem to be single-brooded.

A gallery of beaks and bills

These birds show the astonishingly wide range of functions served by the bill. They are arranged in random order because no really comprehensive categories exist. Even the insect eaters, the most obvious group, include birds that are very dissimilar. Indeed, the chart illustrates diversity, not symmetry of any kind.
Note: Beak and bill are interchangeable terms.

Hawfinch: A unique and powerfull bill for a bird that is a nut and seed-eating specialist.

Robin: A generalised insectivore, hunting on the ground, in trees and also in the air.

Great spotted woodpecker: A strong hammer-and-chisel bill for cutting into both hard and soft wood.

Merganser: A fish-eating duck which is equipped with a saw-toothed bill for holding prey.

Peregrine: Like all the raptors, its bill is specially shaped for tearing prey.

Blackbird: General-purpose beak for eating worms, fruit, seeds, bread, spiders, insects and larvae.

Black-headed gull: A bill like a pair of shears, useful for scavenging almost anywhere.

Heron: Strikes suddenly to stab through the body of a fish, frog, large insect or even a dabchick.

Swift: Its bill is used in the manner of a sweep-net to collect insects while flying.

Partridge: General-purpose bill for various foods from leaves and buds to insects and seeds, including grain.

Treecreeper: Like a pair of tweezers, its fine beak is used to pick up insects from fissures in bark.

Shoveler: An unusual shape of bill, containing a sieve for filtering plankton from the water.

Wigeon: With the tip of its bill it cuts blades of grass, its main form of food, throughout the year.

Snipe: It probes under the turf with its long bill, which is able to feel for worms.

Puffin: This bird is our best example of the use of a colourful bill for courtship display.

HARVEST FROM THE SEA

Britain's fishing fleets land several hundred million pounds' worth of fish – over half a million tonnes in weight – each year; but throughout European waters, this increasingly efficient industry is in grave danger of taking too many fish from the sea.

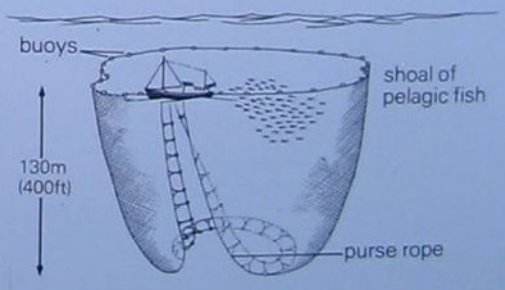
Britain is one of Europe's major fishing nations and our fishing industry provides about 70% of British fish and shellfish supplies. In 1981, landings of all types of fish (excluding salmon and trout) by British fishing vessels totalled 745,422 tonnes, valued at £229 million. This diverse industry, which is spread all round the 9600km (6000 mile) coastline of the United Kingdom, forms an important source of employment and income in a great number of ports.

Fish caught Over 50 different species of fish and shellfish are taken in the waters around Britain. Demersal fish (caught on or near the bottom of the sea) such as cod, haddock, plaice and rays, account for about half the weight of the total British catch. As in previous years, cod was the most important demersal species in 1981 but others, such as dogfish, whiting and coalfish (coley or saithe), formed important catches at many ports and found a ready sale. Pelagic fish such as mackerel, herring, sprat and pilchards live and are caught near the surface and formed 40% of our landings. Shellfish, which included lobsters, oysters, scallops and scampi, only represented 9% by weight of the British catch but their value was in excess of £37 million.

Main fishing methods Most of the fish we eat is caught in a trawl net made from nylon and dragged along the sea-bed by a trawler. Large trawlers can be over 100m (330ft) long, but today some 90% of the British catch is taken in fishing boats less than 28m (90ft) long. They still have similar equipment to the larger trawlers, including special echo sounders to locate the fish and powerful winches to haul the nets back aboard, when the skipper decides he has a good catch. As well as by trawling, fish are also caught by 'long lines', which carry several hundred baited hooks; by drift or tangle nets; by seine netting, which is a form of trawling used to catch concentrations of fish on or close to the sea bottom; and by purse seining, which catches surface shoals.

Poorer catches We often read that certain fish species are in danger because too many of them are being caught. Fish such as cod, haddock and herring are indeed being over-

Purse seining



The ship sails round laying the net in an arc, hoping to enclose a shoal of fish. The purse rope is hauled in to bring the catch aboard.

Left: As well as fish, man has learned to use other foods from the sea. Among these are seaweeds – some are eaten, such as the laver bread of South Wales, while others are turned into alginates and used to thicken ice cream or to make shampoo or drugs.

Opposite page: Fishermen at work on deck in Stornoway in the Western Isles. In 1980 Britain's fishing industry provided 16,700 regular jobs for fishermen.

fished – the result is poor catches, often including a high proportion of young fish – a situation which presents a grave threat to the future of the stock, and of the industry itself.

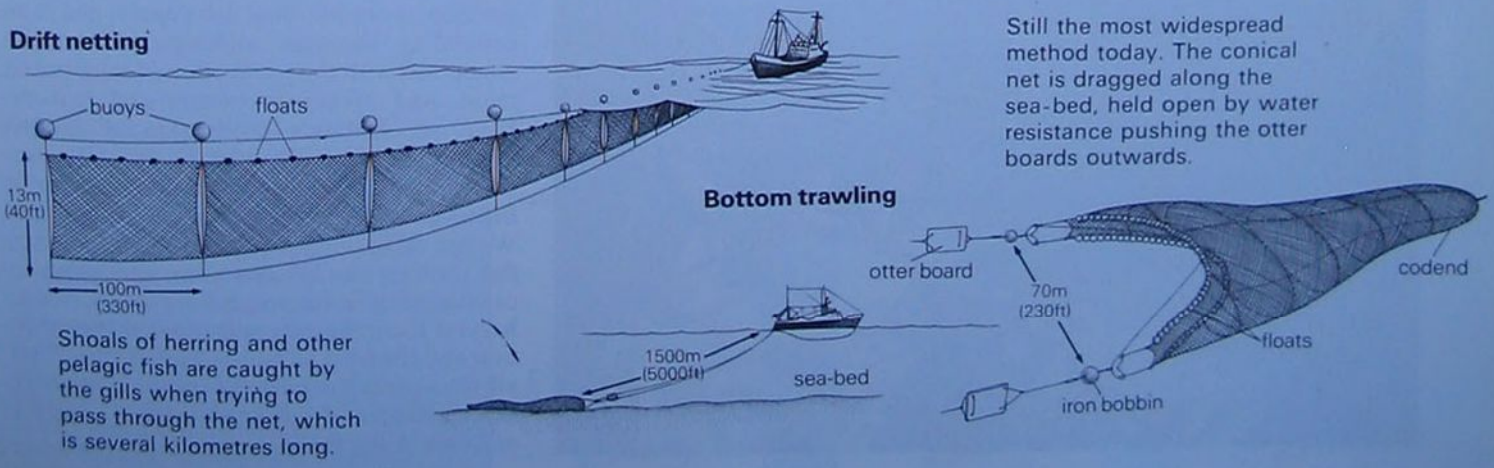
Among the distant water stocks traditionally exploited by UK fishermen, the first to suffer in this way were the various cod populations of the North Atlantic. As Europe's deep sea fishing industry modernised itself and used large freezer-equipped stern trawlers capable of towing huge trawls, the cod catch from the north-east Atlantic by all nations, including the Russians, rose to over 2 million tonnes. Cod stocks around Iceland were badly depleted by overfishing and fell from a peak of 547,000 tonnes in 1954 to 345,000 by 1967.

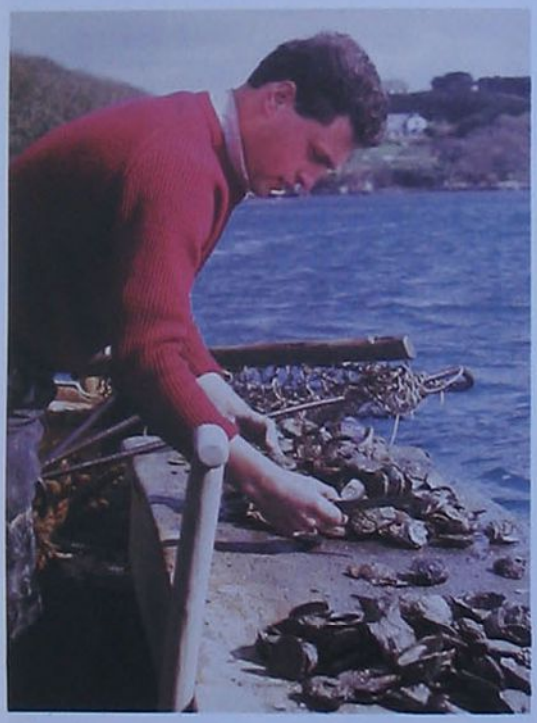
Conservation needed When catches fall as they did in the cod fishery in the north-east Atlantic, the stocks must be protected by conservation measures. Fisheries management can be implemented in various ways, such as by restricting the type of fishing gear, limiting the length of the fishing season or the size of the fleet, and by controlling the total allowable catch (TAC). A widely used conservation method is to restrict the size at which fish can be landed; another is to enforce the use of larger meshes in trawls or other nets.

In the attempt to conserve fish stocks, countries have extended their fishing limits. In 1971 Iceland extended her limits from 19km (12 miles) to 80km (50 miles); this was a serious blow to our industry because as much as 90% of the British catch came from this coastal zone. Poaching took place and the story of the Cod Wars is well known. In October 1975, when the Icelandic limits were pushed out even further to form a 310km (200 mile) zone, there was further conflict as British trawlers ignored the new limit and fished inside it, guarded by the Royal Navy.

Since 1977, Britain's fishery limits, like those of other EEC member states outside the Mediterranean, have extended to 310km (200 miles) or else to a median line or agreed boundary if the countries are close. Certain countries have the right to fish up to Britain's

Below: A Fleetwood trawler, the *Glen Helen*, one of the remaining distant water trawlers operating from Fleetwood in the 1980s. Now that Icelandic and Norwegian waters have been denied to the British fleet by the extension of national limits during the 1970s, the *Glen Helen* works in the Irish Sea and off the north of Scotland. The distant-water fishing ports such as Fleetwood, Hull, Milford Haven, Grimsby and Aberdeen have fallen into decline.


Drift netting
buoys
floats
13m (40ft)
100m (330ft)
Shoals of herring and other pelagic fish are caught by the gills when trying to pass through the net, which is several kilometres long.
Bottom trawling
Still the most widespread method today. The conical net is dragged along the sea-bed, held open by water resistance pushing the otter boards outwards.
otter board
70m (230ft)
codend
floats
1500m (5000ft)
sea-bed
iron bobbin



Above: Lobsters are caught close inshore in pots. The European lobster is one of our most sought-after species, and catch levels have fallen because of the intensity of fishing. Stocks have to be protected by a minimum landing size.

Left: Sorting oysters at Helford oysterage in Cornwall. In the background is the dredge, made of ropes and a wooden spar. Besides dredging for 'wild' oysters, oyster cultivation is now a prospering business. Even scallops and mussels can be cultivated—all these species being grown on trays, ropes or nets suspended in the sea.

Below: A mixed catch of bottom fish, still on board a trawler in Plymouth.

19km (12 mile) limit, but to date no foreign vessel may fish within 9.6km (6 miles) of our shore.

Shellfisheries In the fishing industry and generally in fishmongers' shops, crustaceans are included among shellfish, and so the term shellfish includes lobsters and crabs, which are caught in baited traps on the sea-bed. The most important crustacean for British fishermen is the Norway lobster (*Nephrops norvegicus*), which is found on soft muddy bottoms around the north-east and west coasts of Scotland, in the Irish Sea and the western approaches to Ireland and Cornwall. These lobster-like creatures are caught in large numbers, mainly in trawls, and are then landed fresh at processing factories where they are washed, peeled and frozen ready for sale. Sold as 'scampi' they are found in most supermarkets and are probably one of the most favoured seafoods.

Shellfish farming is growing in importance. This includes the cultivation of oysters, mussels and clams in certain parts of our coasts. Oysters sold in Britain fall into two main groups—the flat oyster and the cupped oyster, the latter being the Pacific oyster (*Crassostrea gigas*) which was introduced into Britain in 1965 by the Ministry of Agriculture, Fisheries and Food (MAFF) from British Columbia in western Canada.

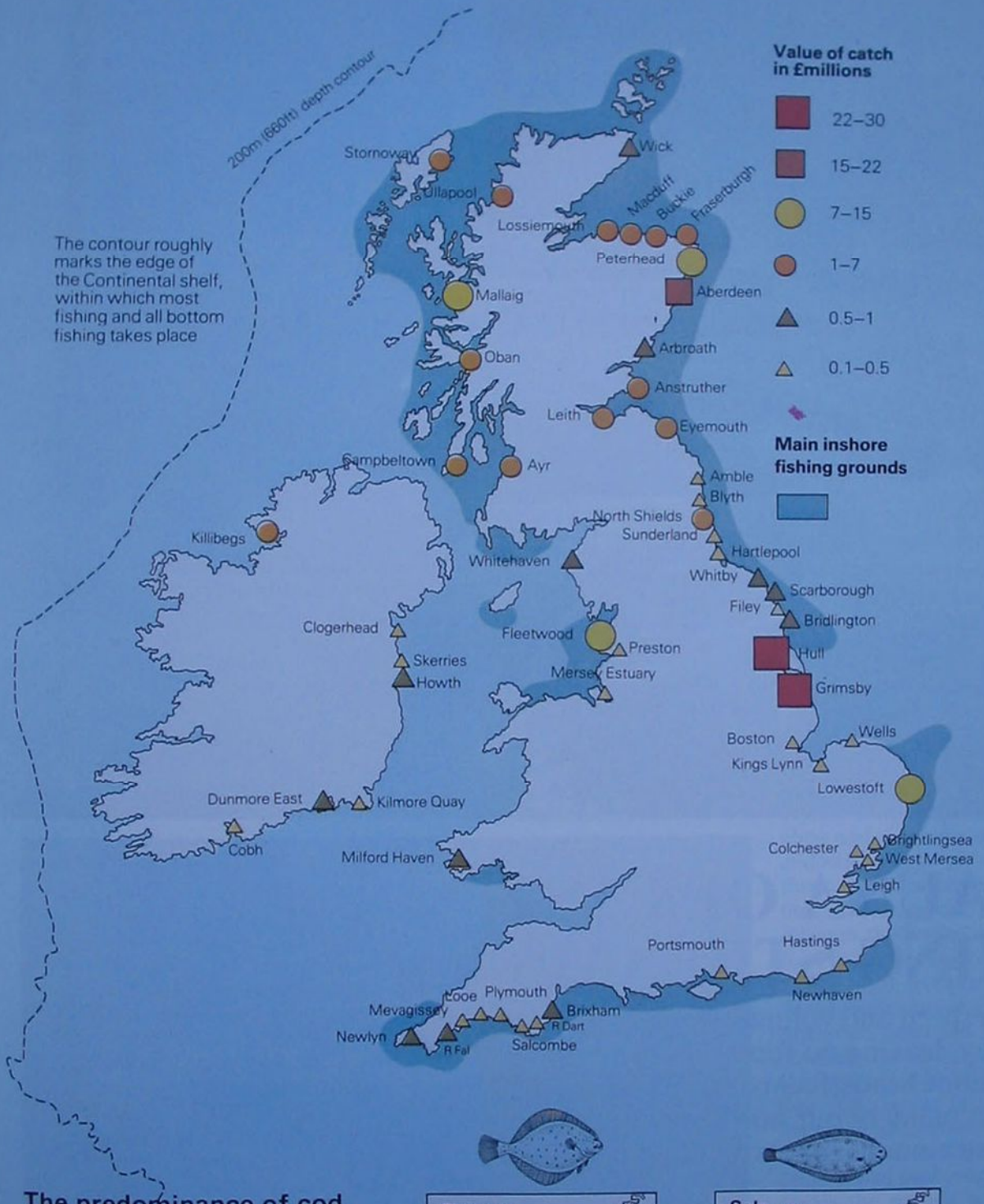
Cockles and mussels are mainly taken from natural beds but there is a rising business in growing mussels on hanging ropes, or in nets which are suspended from buoys or rafts.

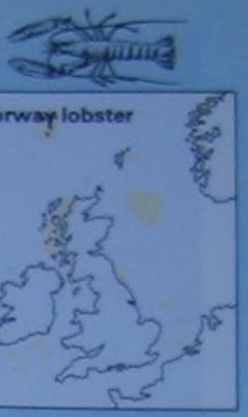
The future of fishing The decline of the British deep sea trawler fleet and reduced landings at major ports such as Hull and Grimsby has brought better fish prices and higher wages to our inshore fishermen, but there is mounting concern that the available stocks of both fish and shellfish are being overexploited. Britain's fishermen fear that they will also be compelled to share stocks within our limits with fleets from the other EEC countries. To add to the problem, Spain and Portugal have also applied to join the Community, both countries having large fishing fleets desperate for fishing grounds.

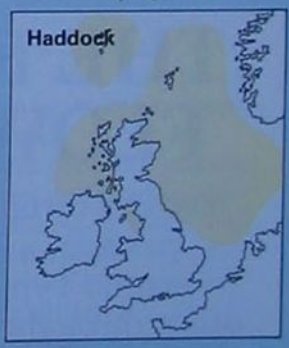
Will fish farming help? Fish farming does appear to have a growing place in the production of our national fish supply, and is an expanding business, although still mainly concerned with the production of salmon and trout, and of course oysters and mussels. Even so, Britain's production of farmed marine species is dwarfed by the UK consumption rate of nearly a million tonnes of fish a year, about a third of which is imported. We are still a long way from the stage when fish farming can be seen as an alternative to catching fish in the sea. So the future of our harvest from the seas still rests on conservation and the need to rationalise fishing so that all who participate in this valuable industry can be assured of sustained yields of a variety of fishes in the future.

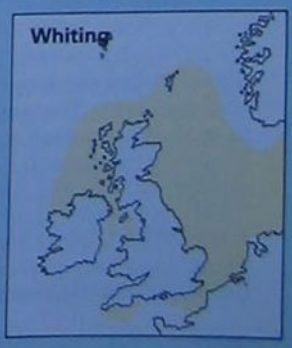
Fishing in the British Isles

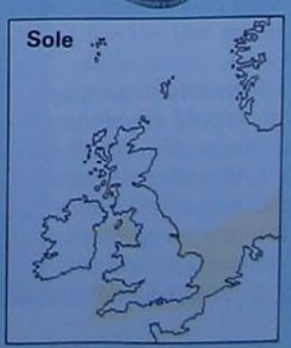
Fleets from our main ports select their fishing grounds according to the catch they seek. The maps show our main national fish resources in the 1980s.





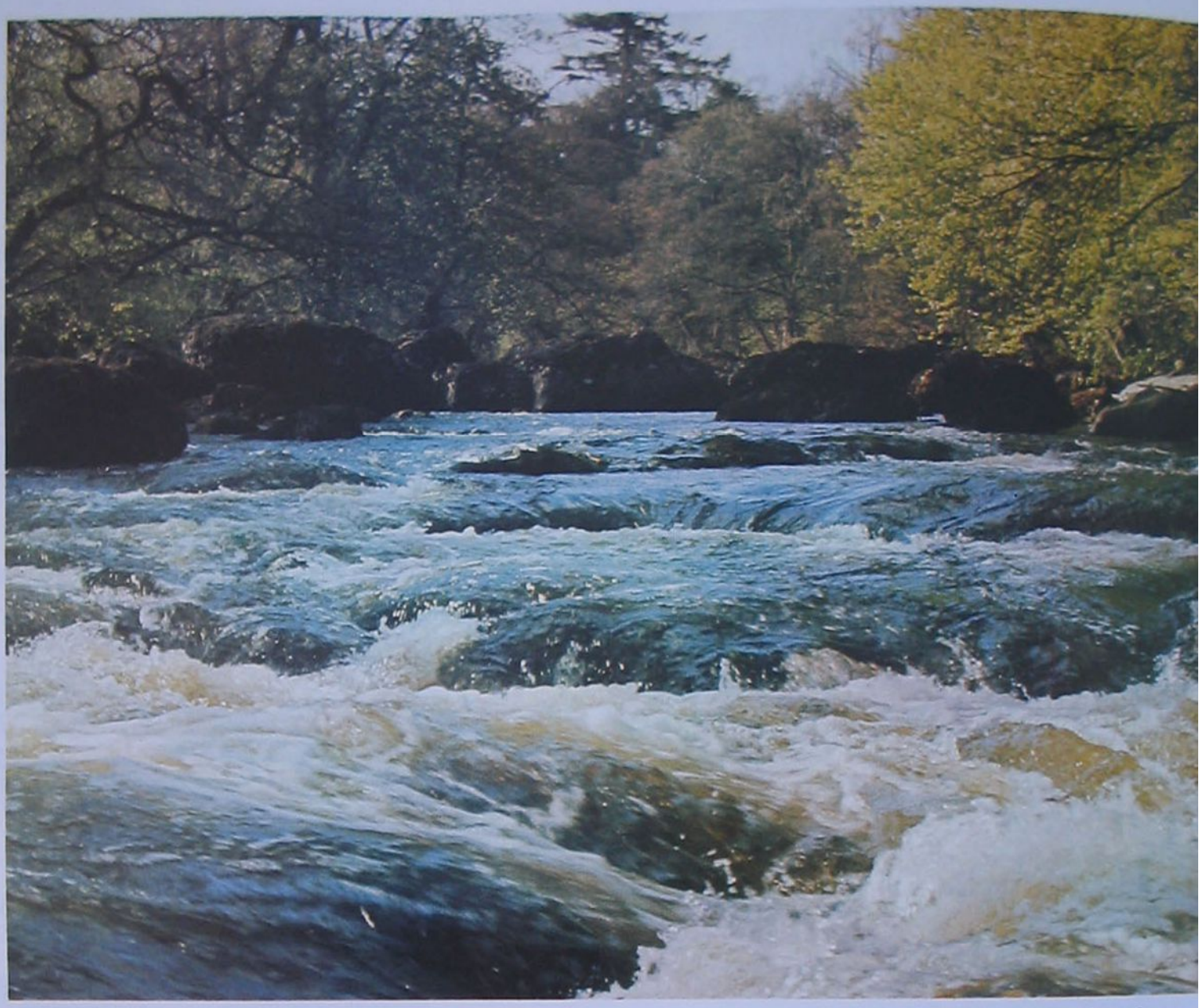






The predominance of cod

Even more widespread than the most widely fished species shown in these maps—haddock and whiting—cod is caught in many fishing grounds in the north-west Atlantic, including the North and Irish Seas. In 1981 British vessels landed 80,000 tonnes of cod. Despite falling consumption and higher prices, and despite attempts to commercialise species such as coley, cod remains our most popular fish.



THE FAUNA OF FAST FLOWING STREAMS

Above a certain speed and volume, water carries fine particles away, leaving no foothold for rooted plants. Typical of headstreams, such conditions occur throughout many of our northern river systems. Their stony substratum harbours an abundant fauna.

Above: A fast-flowing Highland river. The animals in such streams face an unending struggle to find enough to eat—and find it before something else does. When animals are many, some face a second problem—avoiding carnivores.

In a habitat where there is plenty to eat you would expect to find plenty of animals. However, if conditions are uniform, as in a stream flowing over smooth rock, or if some non-biological factor is unfavourable, an abundant population may comprise a few species only.

Some animals of fast-flowing streams are specialised to cling to an exposed surface, while others obtain their food by filtering the water, but many show no particular structural adaptations, and find shelter from the current among the stones. In Britain many of these unspecialised animals are confined to running water, where evidently the low temperature and high concentration of oxygen favour their existence; but further north, however, they may extend into lakes. Some animals in our latitudes occur in both still and running water. On the other hand, those that rely on a current to bring their food can live nowhere else.

In a stream, as in other environments, the structure of the community is shaped by the interactions of the species in the struggle to obtain food, and also by the unique feature that the ambient medium, the water, is constantly flowing in one direction—one missed foothold and the individual is swept away.

Composition of the community Insects predominate. The larvae of stoneflies, mayflies and caddisflies are, almost without exception, aquatic. The same holds for two families of the true flies—the non-biting midges (chiro-

Above: A stonefly larva in a hill stream. The food supply is scarce at the top of a stream rising high in the mountains and here stoneflies outnumber all other groups of animals. They appear to be adapted to a meagre food supply and to cold water, for none achieves more than one generation in a year, unlike some other species in different groups. Many grow during the winter and survive the warm season as eggs. The differing levels of temperature and amount of food in a stream thus contribute to faunal diversity.

Below: Blackfly larvae attached to a stone in a fast-flowing stream. They are filter-feeders.

nomids) and the buffalo gnats (simuliids). The winged adults generally live a short life devoted to reproduction and dispersal. Representatives of other insect orders are few.

In other groups the common stream-dwellers comprise a few crustaceans, notably *Gammarus*, the freshwater shrimp, and sometimes crayfishes; a few snails, of which *Ancylus*, the freshwater limpet, is well-adapted to life in a torrent; of arachnids, many species of watermite; the flatworms; some worms; and of the fish, the trout, the bullhead and the stone loach.

Food for all There are two main sources of food for these creatures, the first being, as in most communities, the living vegetation. Algae attach themselves to illuminated surfaces and thrive on the nutrients carried in the continually passing water. The other source, often the more important, comes from the dead leaves of land vegetation. The animals that eat the leaves cannot digest the tissue but fungi invade it and break it down, so providing the nourishment for the leaf-eaters. Large animals with powerful jaws chew and shred the leaves, while the less well-endowed scrape the surface and skeletonise them. Small pieces broken off by the shredders and scrapers, and what has passed through the bodies of these animals, supply food to the detritus feeders.

The algal felt provides food for grazers. Some caddis larvae graze, protected by their sandgrain cases but hindered by them from reaching the most exposed pastures, which are the feeding grounds of two groups of mayflies. The larvae in one group are streamlined and able to swim rapidly; those in the other are flat, with legs spread out sideways to give a broad anchorage so that they can move across the surface with great ability in all directions. Another common grazer in exposed situations is the freshwater limpet which, like its much larger marine counterpart, can resist the current by means of its sucker-like foot and predators by means of its shell. It cannot, however, move fast enough to avoid the rolling stones of an unstable stratum.

Among the stones are cased caddis larvae,

most of the stoneflies and some mayflies. They feed on detritus and are most numerous where the current is slack, for that is where the detritus settles. Some of the stoneflies have elongated flexible bodies, a modification which enables them to inhabit the narrow passages between small stones.

The main shredders are caddis larvae and the freshwater shrimp, which appears to be intolerant of the low concentration of oxygen found in some ponds, but otherwise has a wide distribution. It is abundant in most streams, notwithstanding a lack of adaptations to life in a current–it is not a good swimmer and has no specialised clinging organs. Its adaptation is one of behaviour; exposed to a current, it immediately seeks shelter among the stones, and it also has a tendency to move upstream.

Above: The dipper is one bird that will actually enter the water to catch invertebrates in upland streams.

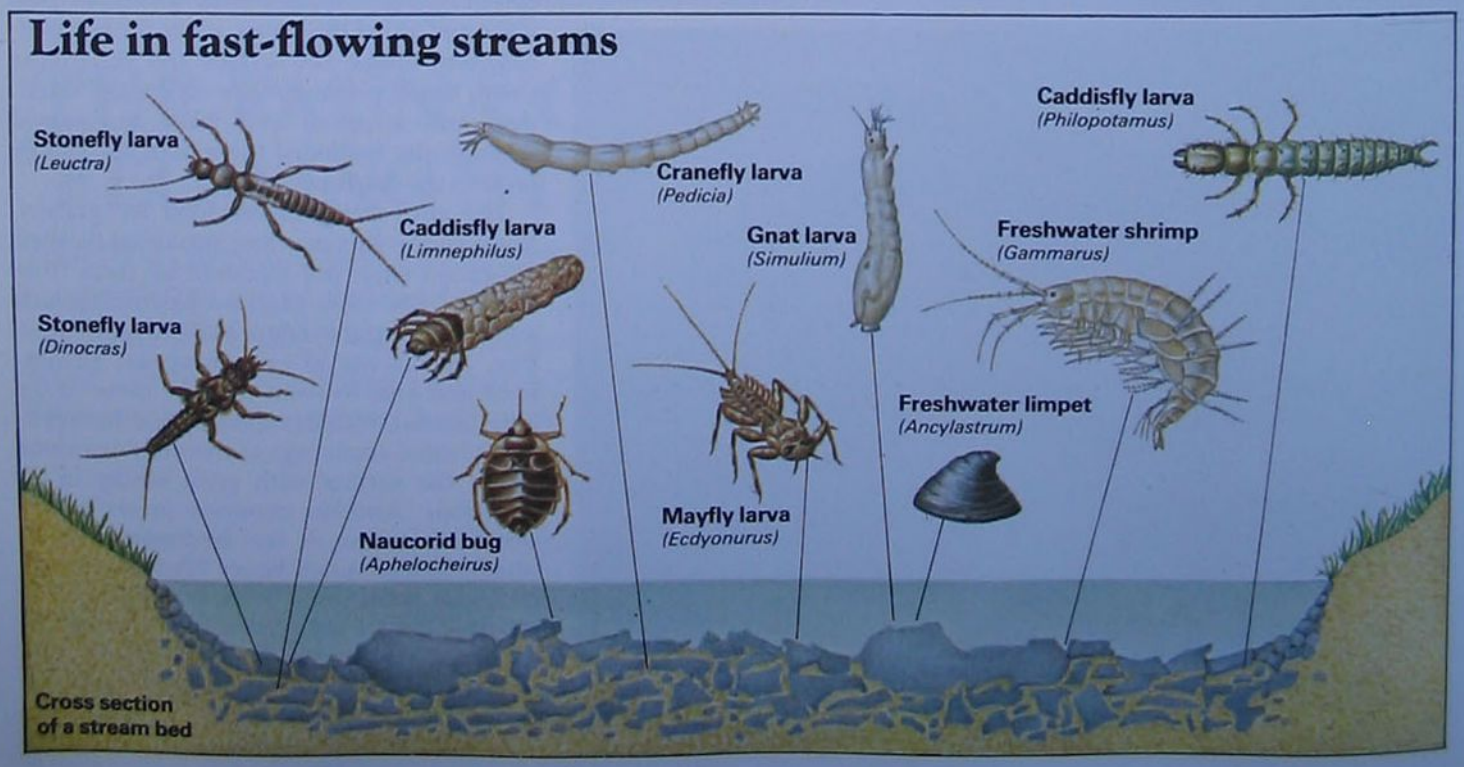
Right: The freshwater shrimp *Gammarus pulex*. Pushing and jostling for position among individual shrimps in the stream leads to displacement, producing a fairly even population along the length of the stream.

Below: Most members of the fast-flowing stream community have their own place, to which they are specially adapted.

The filter-feeders are adapted to the peculiar conditions of flowing water and can live nowhere else. Larvae of *Simulium* cover an exposed surface with a network of silken strands to which they attach themselves by means of a circle of hooks at the end of the body. They hang from this holdfast and rake fine particles from the current with highly modified mouthparts. Several families of caddis do not make cases but spin nets to filter the water.

The carnivores Several species of stonefly are among the largest of the stream-dwelling invertebrates and they prey on smaller animals. So do the Rhyacophilidae–caddis larvae which make neither net nor case and range freely over the substratum. They, too, are large, and many smaller organisms avoid them by inhabiting crevices too narrow for the hunters to enter. The smallest larvae of some mayflies and stoneflies may be found deep in the substratum.

Current too may offer protection. A herbivore has only to cling and its food lies im-



mobile before it. A carnivore has not only to cling but to stalk, seize and overpower an active prey, which is likely to be difficult in water that flows above a certain speed. The flatworms, another carnivorous group, lacking hard structures and organs with which to seize and overpower prey, entangle it in sticky mucous trails which they lay down on the surface. Trout feed mainly on creatures which have lost their foothold and, of course, at the surface.

Among the birds, the dipper enters the water to catch invertebrates in upland streams. Many other birds enter the food chain and most insectivorous species probably feed, at least occasionally, on the adult insects that emerge from streams—nutritious morsels, for the females are usually heavy with eggs ready for laying. In this way material originating on land, passing to the water via leaves shed in autumn, returns to the land. In no other system is there less re-cycling of organic matter.

Diversity of the fauna The resources are exploited in these various ways, but in each category of exploiters there are many practitioners. It is an accepted ecological principle that two species competing for limited resources must differ in behaviour in some way. One difference common in streams lies in the life history. Among the stoneflies, for example, there are several genera where species emerge one after the other, so that the immature stages are not the same size at the same time and not eating exactly the same food. In other groups the succession is in space, not time, the different species occurring down the length of a water course. A recent study of the Hydropsychidae, a family of net-spinning Trichoptera, has revealed such a succession and shown that each species has a different optimum temperature, coupled with which is an increasing tolerance of low oxygen concentration.

Above: Warnscale Beck—a typical fast-flowing stream. The effect of human activity on our rivers—especially of our sewers and industrial effluent—has been well documented. The engineer likes vertical sides and a uniform depth, the achievement of which creates less diverse conditions with consequent reduction in diversity of flora and fauna, and power stations raise the temperature of the water. Nor are upland streams immune. Their water, dammed to create a reservoir, is of good quality and gravity takes it to where it is wanted. The resulting changes in flow, temperature and food supply affect the natural fauna. Also, in the uplands there are deposits of copper, lead and other metals. Few are exploited today, but the spoil heaps remain and rain leaches the metals from them in harmful concentrations.

Left: A bullhead camouflaged on river bed gravel. Trout and stone loach can also be found in upland streams.

Other changes in the environment also make for faunal diversity. A dam, for instance, makes conditions suitable for plankton, some of which, passing downstream, increase the food for net-spinners and lead to a rise in their numbers.

Colonizing the length of a stream A net set in the open water gathers a varied selection of the inhabitants, particularly during the night. Species tend to drift downstream when they are growing most rapidly and therefore, presumably, feeding most avidly, and this occurs at times when there is no increase in flow.

No-one has observed exactly what happens, but probably attempts to reach ungrazed pasture where the current is just too strong lead to dislodgement, and there may be pushing and jostling in a dense population. Many individuals are not carried far before they regain the safety of the stones, but there is a constant displacement downstream of most of the fauna. Obviously *Gammarus*, aquatic throughout life, has no option but to walk back to reach the ungrazed pastures and its tendency to move upstream leads to overcrowding at the top, increased pushing and jostling and increased displacement, which eventually produces a uniform population throughout the length of a stream.

FURNITURE WOODS

Despite recent advances in new materials, much of our furniture is still made from solid timber, whether home-grown wood such as beech or teak from the tropics.

Throughout the world and for thousands of years people have recognised the fact that wood is the perfect natural material for furniture, combining as it does an ability to be cut, carved, planed, glued, turned, bent, coloured and polished with a choice of patterning, weight, durability and hardness.

Which woods are used in furniture making has always been influenced by availability–hence the traditional popularity of oak in Britain. During the 17th century various foreign hardwoods began to be imported into Britain and have contributed greatly to the development of furniture styles. The most important of these was mahogany, which increased in popularity with the abolition in 1733 of the import tax on exotic woods. This heralded the 'Golden Age of Cabinet Making', with names such as Chippendale, Adam, Hepplewhite and Sheraton, who all combined the new wood with French trends towards daintiness in furniture design.

Since those days the increasing pressure on the world's resources of timber has led to constraints over the types of wood used in furniture. Some that were once widely available are now increasingly rare. A dramatic example is the furniture wood ramin, supplies of which were first exported from South-east Asia and Indonesia during the 1950s but are now in jeopardy only 25 years after the discovery of the wood by the Western world.

Above and below: Some furniture is still made in small workshops, such as that of chair-maker Stewart Linford in the centre of the Chiltern Hills in Buckinghamshire. In the above picture, yew wood that has been steam-treated is being bent for the back of a chair, and below, the final product is being given a coat of sealer.

Today three main categories of furniture are produced: 'utility' furniture, constructed from processed wood such as chipboard, plywood and blockboard and finished with a plastic or timber veneer; solid furniture, reflected in the current fashion for pine and teak; and the increasingly popular 'reproduction' market.

Imports and home-grown Most of our furniture wood is now imported, despite the apparent abundance of trees in some parts of Britain and several major reafforestation schemes. Both large manufacturers and the numerous small-scale workshops employ buyers to scour the British countryside for suitable logs, but this represents only a small fraction of the furniture wood used in Britain. The rest comes mainly from Continental Europe and North America.

British sources of furniture woods include our native and long-naturalised timber trees–oak, beech, ash and elm. Other, rarer, trees such as walnut, sweet chestnut and yew are much sought after. A high proportion of the best British furniture timber is used nowadays as veneers in high-quality reproduction pieces.

Imported logs are checked rigorously for disease. Dutch elm disease was introduced into Britain in the bark of imported logs, causing the present disastrous epidemic, and

elm, oak and sweet chestnut are now not allowed into this country unless their bark has been removed, for fear of introducing further diseases.

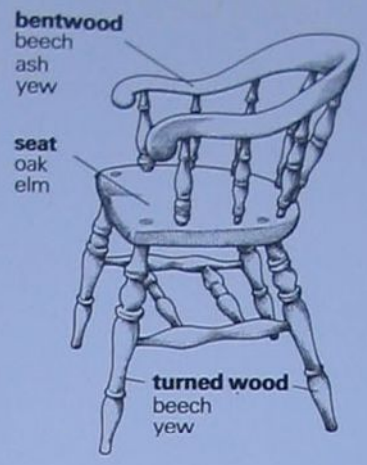
Some temperate-zone woods are imported for use in solid furniture, for example, American white oak may sometimes feature in modern fitted kitchens. Pine, which is so often seen in solid furniture is mostly imported from Sweden or the USSR. Tropical woods are used for both solid furniture and for veneers. The most common examples are teak (mostly from Burma and Thailand), mahogany (the best comes from Brazil), afrormosia (from West Africa) and rosewood (mostly from India and Central America). Most of our man-made timber boards contain foreign woods and, indeed, are manufactured abroad.

Hardwoods for different uses Each type of timber has its own particular properties and characteristics, both mechanical and aesthetic, which make it suitable for certain uses. The underlying reason for these differences is in the wood's structure—the types, sizes and arrangement of cells in the heartwood. Trees such as oak, elm and beech, which are all hardwoods, have a xylem consisting primarily of fibres and water-conducting vessels. The hardness of the wood is related to the fibre content, and the straightness of its grain is determined by the straightness of the fibres. The vessels mainly determine the texture of the wood: woods with wide vessels are said to have a coarse texture.

For example, oak has numerous fibres and wide vessels, so it is both hard and coarse, making it difficult to work. Birch and beech, however, have narrow vessels and are fine-textured woods. Beech has become increasingly popular over the years because its straight grain and hardness make it easy to work and it turns, bends and polishes well.

That some woods such as oak are difficult to work is reflected in certain characteristic styles and uses with which they are associated. Oak construction tends to be rough and massive, with carving in bold relief. Elm is likewise difficult to work, being coarse with a wild and wavy grain. With the development of sophisticated and more efficient drying techniques it is now being used successfully in solid furniture. In the past, however, it had only rough outdoor applications, such as farm

The parts of a chair



The range of properties offered by different timbers is exploited by using more than one wood in a piece of furniture. In a typical Windsor chair—a type of chair in which the parts are socketed together—beech or yew is used for the turned parts. These are fitted into an elm or oak seat, both tough woods that can withstand the force needed to bang them in. Flexible beech, ash or yew is used for the bentwood back. Stewart Linford's Windsor chairs (above right) have an elm seat with both the legs and the back of yew.

Below: Planks of elm are slowly dried for up to two years before being finally dried in a kiln. During the last ten years our elm population has been devastated by Dutch elm disease. Fortunately, however, only the sapwood is attacked. The heartwood remains unaffected and can still be used for furniture making.

Above: The abolition of a tax on foreign woods brought about the Golden Age of Cabinet Making in the mid 18th century. This mahogany cabinet is thought to have been designed by the furniture maker, William Vile, in 1760.

Left: The wild wavy grain of elm is used to great effect in this table top.

buildings, wharves and coffins, where its great durability was more important than an accurate finish.

Softwoods for furniture The structure of softwoods–woods of coniferous origin–is quite different from that of hardwoods. The role of the fibres and water-conducting vessels is combined in one type of cell, called a tracheid. In general, the structure of a softwood tends to make it weaker, and so less useful in furniture making, than a hardwood. An exception to this, however, is pine, reflected in the resurgence of pine furniture in recent years–a phenomenon that reflects the current awareness of the attractiveness and value of natural wood. The subtle variations in colour and the presence of knots add interest and warmth that is lacking in artificial laminates.

Softwoods are, however, a very important component of man-made boards used in utility furniture.

Veneered furniture Many decorative woods are scarce and therefore limited to being used for veneering–the technique of glueing a thin layer of an attractive wood on to a backing of relatively plain but strong wood or board. Veneer woods chosen for their attractive appearance include cherry, walnut, sweet chestnut, yew and many foreign timbers, particularly mahogany and rosewood. Even teak, which was once widely used for solid laboratory furniture because of its resistance to acid and heat, is now often used simply as a veneer in such applications.

Other woods are used in veneers for marquetry and inlaying. The former is the assembling of a pattern from thin leaves of wood; the latter is the filling-in of a recessed design cut into a background of solid wood. Holly and whitebeam are used for this, as are tulipwood (from Brazil and Burma) and satinwood (of which there are two types, one from the West Indies and the other from Sri Lanka). Strongly coloured woods are often used, ebony being the obvious example.

Hidden woods The complete opposite to veneering is the use of woods that do not need to be attractive because they are used in the parts of furniture that remain hidden. Both home- and foreign-produced timbers are used. Birch, being tough yet easy to work, is ideal for the frames of upholstered chairs. An example of a foreign wood is virola from central America, which is light and takes a smooth finish, and so is used for the sides of drawers.

Veneering

burr veneer

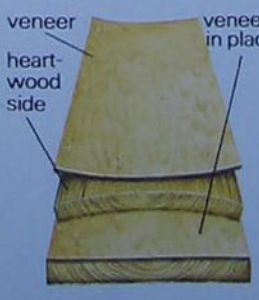
The most sought-after veneers are cut from the lumpy outgrowths (burrs) of a tree trunk such as walnut.

sliced veneer

Sliced veneers are taken by cutting across the whole width of a half-log. The wood shown here is rosewood.

rotary-cut veneer

For a rotary-cut veneer the whole log is rotated against a cutting edge to produce a continuous sheet–here of maple.



Most veneers are laid as a single sheet on to the heartwood side of the backing to prevent warping (left). For best-quality work two sheets are laid cross-grain to each other–called counter veneering (right).

WHAT MAKES A PLANT A WEED?

In Britain we spend millions of pounds each year combating weeds, but why are weeds considered such a nuisance and what harm do they do to crops?

Wherever man cultivates the ground he is faced with the problem of weeds. Weeds occur in every kind of habitat and represent all the different plant families, yet it is very difficult to define what a weed is, since almost any plant can become one in certain circumstances.

Simply put, a plant is a weed when it grows in the wrong place. For example, daisies are a natural part of a roadside verge but are regarded as weeds when they grow in a lawn. More specifically, a weed is any plant that is interfering in some way with the function of the place where it grows – water lilies growing in an ornamental lake are desirable, but the same plants growing profusely in a canal are weeds because they block the passage of watercraft, and so interfere with the function of the canal.

Whether a plant is a weed or not can also depend on the time of year. Farmers often sow seeds of rye-grass in spring in a field where winter wheat is already growing. The wheat plants are already well established so the rye-grass does not affect them. After the wheat is harvested the rye-grass provides a useful second crop for hay, silage or grazing. But if the rye-grass is sown at the same time as the wheat, or if wild rye-grass invades, it can smother the wheat seedlings and, in this circumstance, is regarded as a weed.

Why are weeds harmful? The reason why weeds are considered harmful is that they interfere with the growth of other plants. They can do this in several different ways. Weeds tend to be fast growing, quickly establishing themselves and shading out the slower-growing crop plants. This prevents adequate sunlight from reaching the leaves of the crops, producing smaller, weaker crops and a reduced yield. The most important weeds in this category are broad-leaved species such as cocklebur. Grasses and other slender species are not nearly so harmful in this respect because they cast only a small amount of shade.

Weeds also compete for the nutrients and water in the soil, reducing the amounts available to the crops. In particular, weeds such as fat hen have the ability to remove from the soil very large amounts of sodium, potassium and other important elements. The crops are thereby deprived of essential foods and the soil becomes impoverished.

Above: Any plant growing where it is not wanted is a weed – by that definition the plants along the sides of this path are most certainly weeds. Growing where they do, their roots could well damage the path or the walls next to it, and they are also unsightly (at least, to many eyes). The weed with the white flowers is hoary cress, an introduced plant that is now common on wasteland, banks and paths.

Another form of competition between crops and weeds is for living space. The presence of large numbers of weeds in a field reduces the amount of soil available to the crop's root system. The crop therefore develops smaller root systems, which are less efficient at taking up water and minerals. The shoots, too, may become crowded and cast shade on each other.

Many weeds suppress the growth of crops by means of substances called kaolines secreted from their roots. The kaolines interfere with the growth of nearby plants, suppressing their development and producing stunted in-

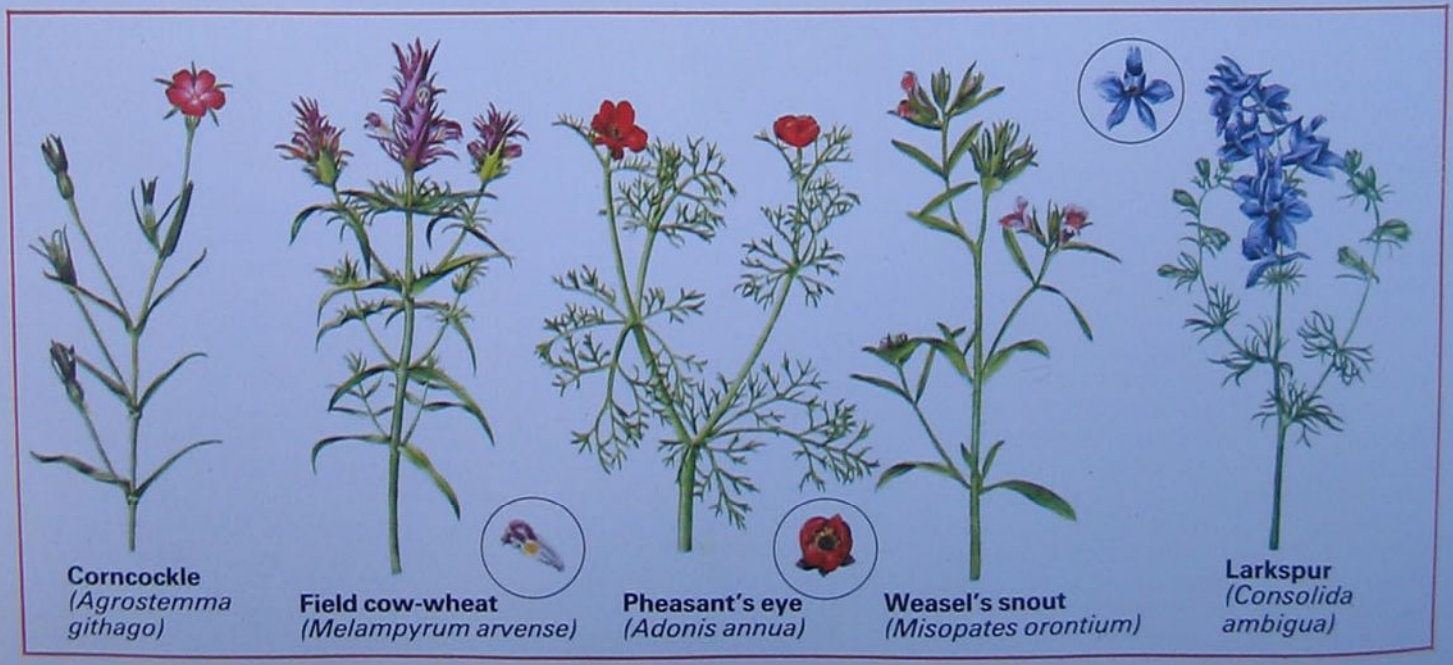
Above: Basingstoke Canal choked with weeds, including water lilies, pondweeds and water-soldier.

Below: All five species here were once common weeds of cornfields but, with the introduction of seed-cleaning techniques, they are becoming rare.

dividuals. The wild oat is an example of a weed that does this.

Worst offenders Although many plants can become weeds, only the most widespread, persistent and tenacious species are of any great importance.

The weeds in this group share several very similar characteristics. Many are ruderal species – that is to say, they are early colonists of disturbed or waste ground. By germinating, growing and reproducing rapidly they are able to take advantage of newly created open spaces before the competition from other plants becomes too intense. Before man began to clear the land for agriculture ruderal plants were restricted to those areas where a shifting substrate created the right conditions for them – rock screes, shingle coasts and glacial deposits, for example. But, as farming (and particularly ploughing) increased, these spec-



ies spread from their former homes into this new, ready-made environment.

Ragworts and poppies are good examples of plants that have increased dramatically in numbers with the speed of agriculture.

The ability to reproduce and disperse seeds efficiently is essential to the success of a weed. A single field poppy may produce up to 400 flowers and 20,000 seeds in one season–a staggering rate of reproduction. Other species have an extremely long flowering period. Buxbaum's speedwell, for example, is able to flower throughout the year apart from during the severest winter weather. In one year, a single specimen may produce between 3000 and 7000 seeds.

Other successful reproducers include groundsel, ragwort and other members of the daisy family. Not only do they produce numerous flowers, their parachute-borne seeds are also a highly efficient means of dispersal.

High tolerance Another factor in favour of weeds is their ability to tolerate a wide range of conditions, unlike crop plants which require the conditions to remain within quite narrow limits. For example, in most plants flowering is triggered by day-length–either the increase in the hours of daylight as summer approaches or the decrease in hours during the autumn. Weeds such as annual mercury, dandelion and shepherd's purse, however, are indifferent to these changes and flower whenever the conditions permit.

Similarly, most weeds can cope with extremes of wetness, drought or cold. Some produce seeds that can survive long periods of dormancy in the ground, germinating as soon as the soil is disturbed.

Weed control In Britain, we spend millions of pounds each year combating weeds. Traditionally, weeds were cleared mechanically by hoeing, or hand-weeding in the case of small areas. These methods are still carried out today, but since World War II spraying crops with herbicides has become widespread.

Some herbicides, such as sodium chlorate, are powerful enough to kill any weed but they render the soil sterile for long periods–perhaps several months. Other, so-called selective, herbicides kill only those plants that the farmer or gardener wishes to remove, but new strains of weeds resistant to these chemicals are beginning to appear.

More successful is the technique of seed cleaning, in which weed seeds are carefully sorted out from crop seeds. This has resulted in a marked reduction in weeds, particularly those of cornfields where species such as corncockle, pheasant's eye and darnel are now becoming rare, though they used to be common and serious weeds in grain crops.

One other method of weed control is biological control, where weeds are kept in check by introducing a natural predator or disease. Although they are being used in countries such as Australia and the United States, they are not yet common in this country.

Sources of disease

Weeds can act as hosts for disease, providing reservoirs of infection. Rust fungus, for example, used to cause severe losses of wheat in Britain. An essential part of the rust's life-cycle involves an intermediate host–the barberry (shown here). So, by eradicating the shrub from wheat-growing areas, the disease can be controlled.

Right: Field bindweed climbing up stalks of wheat. This weed is particularly difficult to eliminate because, as well as producing seeds, it also spreads vegetatively by means of creeping roots and rhizomes. If even the tiniest piece is broken off or left in the ground it will produce a new plant. Another problem presented by bindweed is its deep roots, which can go down into the soil to a depth of 2.5m (8ft), where they seriously deplete the resources of deep-lying water available to other plants.

Below: A neglected onion bed invaded by a variety of weeds, including speedwell and scarlet pimpernel. Left untouched, these weeds will compete with the onions for water and nutrients, and reduce the size of the crop.

THE STRANDLINE: WHIM OF THE WAVES

Representatives of the great hidden storehouse of life in our seas–from the most primitive hydroid to an enormous whale–may, on the whim of the waves, be cast up on the beach. No longer hidden below the surface but open to our inspection, they are to be found in the random straggle of the strandline.

The sea is in constant motion. This is obvious enough on a rough day when the wind has whipped up waves which pound and roar on the beach; but even during calm periods, when hardly a ripple disturbs the surface, great masses of water are being shifted round the coast by tidal currents governed by the phases of the moon. As the water moves, so it transports any material that is floating or in suspension without any independent means of propulsion. A fish may swim against the current, but a dead bird or a cuttlefish 'bone' bobs along at the whim of wind and current. Eventually, a proportion of the sea's cargo reaches the shore where, if an onshore wind is blowing, the waves carry it to the high water mark on the beach, dump it, then leave it high and dry as the tide recedes.

This abandoned material forms the strandline, stretching the length of the beach (until interrupted by rocky headlands, for example). If the next high tide, 12 hours or so later, rises even higher, this jumble of weed and assorted life is pushed even higher up the shore, augmented by the latest arrivals. If, on the other hand, the tides are decreasing their range as they move from springs to neaps, a new strandline forms lower down the beach; then another below that at the level reached by the subsequent high tide. A whole series of strandlines may mark the progress of the tides from springs to neaps–unless, of course, the weather changes and an onshore gale drives them all up to the very top of the beach.

The most dramatic quantities and varieties of strandline debris are usually found after a

Right: Successive tides leave a series of strandlines high on the shore, their presence marked by long lines of rotting seaweed.

Below: Strandline seaweed and shells. Often human–as well as animal–scavengers play a large part in the removal of strandline material. On holiday beaches the authorities fear that the rotting seaweed will prove offensive to the visitors and therefore bulldoze it away. On a more positive note, farmers and gardeners often collect it as a rich source of humus and fertiliser. Whether it is a sackful for the cabbage patch or a trailer-load for the market garden, these sea-borne nutrients have long been collected in the remoter coastal communities–the Isles of Scilly and many of the Scottish Islands, for example.

winter gale, when the prodigious energy of the waves not only transports the existing cargoes but also tears up forests of seaweed, churns living shells from their sandy-bottom havens and even batters molluscs from their rocks.

Strandline seaweeds At first glance, the strandline appears to be nothing more than seaweed, mixed with a variety of man-made junk which always seems to include a smattering of odd shoes, light bulbs and plastic containers of every conceivable shape and size. Closer inspection confirms that seaweed forms the main bulk of the strandline, but a search reveals many creatures which, in company with the weed, have been cast ashore to die.

If the weed is newly arrived it may be damp and glistening, in contrast to that of an old strandline which is dry and cracked on the surface, slimy and rotting in the lower layers. A careful look at the different kinds of weed will distinguish the tenacious disc-like base of the wracks from the huge claw-like holdfasts of the kelps. The different-shaped fronds, green, brown and red, are heaped together irrespective of their position in the living community; they include the wracks with air bladders to float them upwards to the light when the tide is in, and some of enormous length, such as the 6m (20ft) long bootlace weed (*Chorda filum*).

The growing plants form a forest of life, with some creatures feeding on the weed, some seeking protection or attachment on it, and some using it to shelter and retain eggs. But when the weed reaches the strandline these different creatures, with different lifestyles, lie cheek by jowl amid the weed, sharing only the certainty of death.

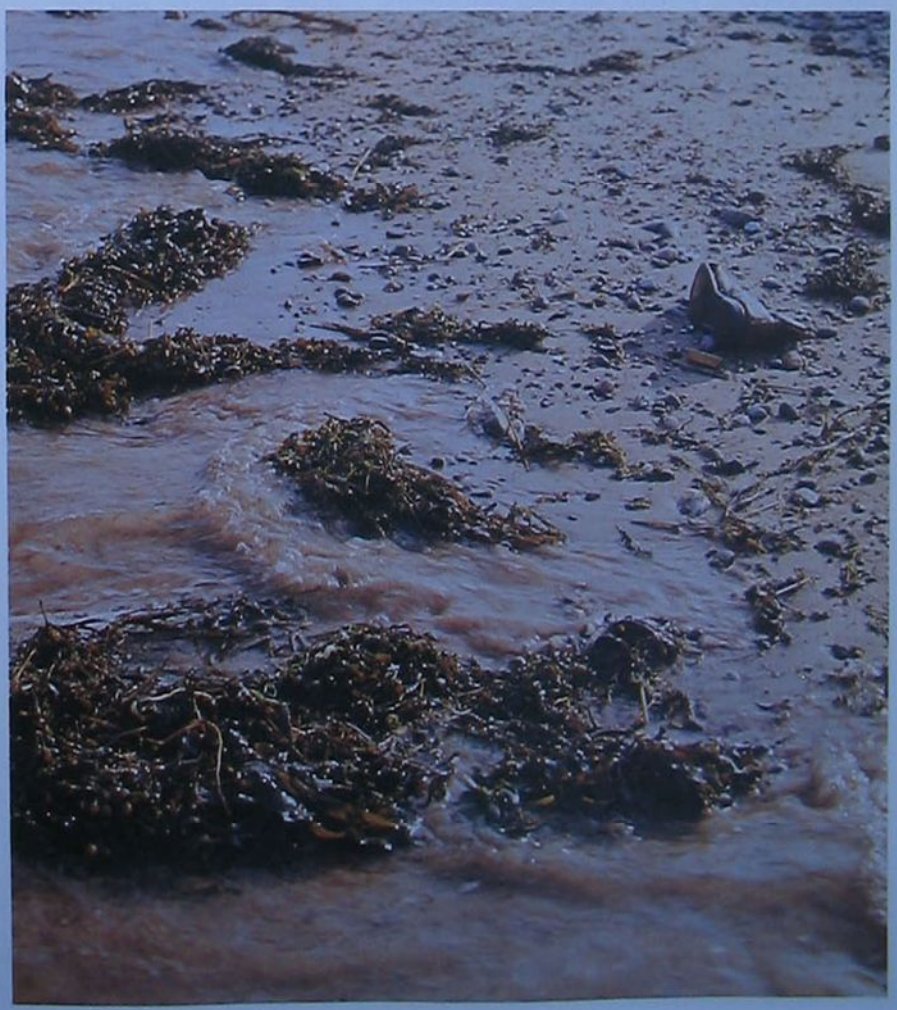
Animals of the strandline A fresh strandline is most rewarding. The fronds of weed may bear rasp marks where common limpets have grazed. A beautiful blue-rayed limpet, for instance, with its translucent shell and rows of bright blue spots, may still nestle in a shallow depression eaten in the stipe (stem) of oarweed, or may be found in a giant holdfast, to which it migrates in late autumn to avoid being carried away when the fronds break after fruiting.

Above right: The holdfast of a strandline seaweed may well harbour a porcelain crab, alive for a while, before it, too, dies.

Below: Seaweed being washed ashore by the incoming tide. Evidence of man's untidy habits are usually all too clear among the detritus of the strandline. The single odd shoe or boot nearly always turns up. Nevertheless, a close look among the seaweeds will also reveal a surprisingly wide range of natural debris.

Many creatures that feed on the passing plankton fix themselves to seaweed; others find temporary shelter. The weed of the strandline displays the limy tunnels of polychaete worms, the flabby remains of sea-squirts and communities of sea-mats that carpet the fronds with compartments, each occupied by one member of the community. The holdfasts may even shelter tiny porcelain crabs, alive for a while.

Some creatures die on the strandline before ever reaching maturity. The most frequently found are the egg masses of the common whelk (a spongy group of off-white egg capsules which together form a mass about the size of a tennis ball), and the 'mermaids'



purses'. The pale coloured purse is the egg case of a dogfish which, with embryo inside, is lashed to the kelp by twisting horny threads. The darker purses, easier to find, belong to the skates and rays.

A variety of common creatures which can be seen easily enough at low water–mussels, winkles, cockles, whelks–are also cast ashore. Some are empty shells destined to form part of the beach sand, while others are meat-filled, forming a ready meal for a scavenger. Yet others are rarely seen except dead on the strandline–razorshells, which inhabit the sand at extreme low water mark and below, sea potatoes, sea urchins, sea mice and sand masons.

Large-scale strandings Some creatures on the strandline stand out by virtue of their sheer size. Dead birds are quite easy to spot–sadly, many of them have died as a result of oil pollution or entanglement with fishing lines. Surface oil takes a particular toll of auks –guillemots, razorbills and puffins–as they spend so much of their year swimming on the surface. Shags and cormorants, too, are ready victims. Some oiled birds which are still alive can be treated at specialist cleansing units, but success rates are not high.

Above: Some of the riches of the strandline on display –among this high tide litter you can see egg masses, crab carapaces, razorshells, cockles, whelks–and even a feather or two.
If you are lucky, you may find a cuttlefish 'bone' among such strandline debris. The cuttlefish is a mollusc but has its shell inside its body rather than outside. It is this 'bone' that floats to the surface when the animal dies and decays. Gleaming white, it is usually easily picked out on the strandline.

Below: Strandline scavengers–three turnstones foraging among the seaweed.

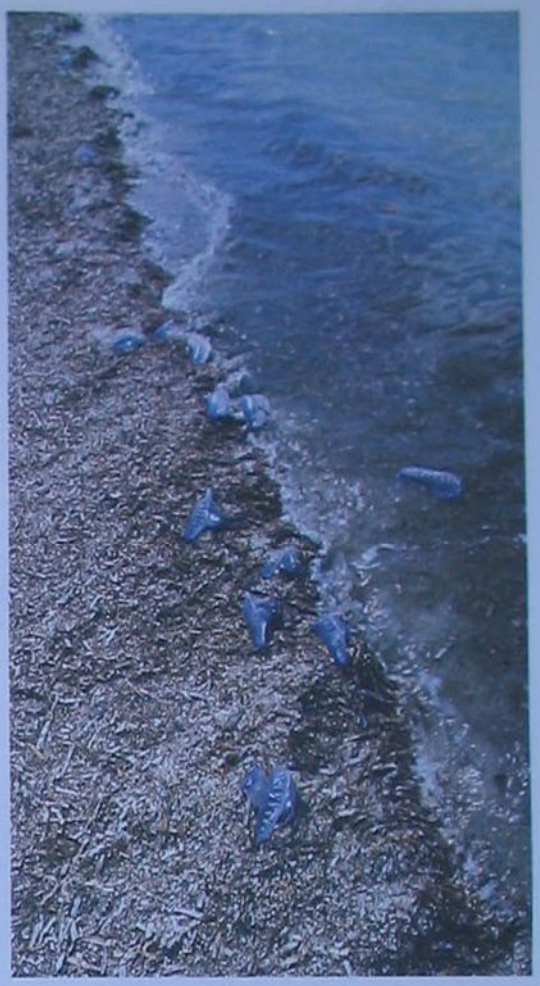
A big animal like a whale or dolphin is obvious enough on the strandline, and quite likely to collect a crowd of sightseers. These air-breathing mammals are destined to die when they become stranded ashore. Sometimes–in the case of pilot whales, for example –they become stranded in large numbers. Any whale found stranded on the beach must be reported to the local Coastguard, who will send details of size, species and other information to the British Museum (Natural History) in London. Large land animals, too –cows and sheep–may be cast ashore via rivers and estuaries and these, like the whales, must be disposed of to avoid danger to public health.

Scavengers and decomposers A large corpse, like that of a whale, or a massive tree trunk, remains for a long time on the strandline if it is not removed, but most of the organic debris soon disappears by natural processes, for the strandline–an ephemeral habitat–supports a full community of scavengers and decomposers. As soon as the material is deposited it is visited by armies of creatures intent upon its destruction. Scavenging sandhoppers, for example, feed on the rotting weed, along with many land-dwelling beetles, worms and flies. Kelp flies lay their eggs where the subsequent larvae can emerge to a rich feast.

More obvious, however, are the birds that patrol the strandline to feed on the debris as well as on the flies and sandhoppers that swarm to it. Herring gulls search out crabs, molluscs, old sandwiches and the corpses of birds and fishes. Here they find the marine equivalent of the rubbish tips on which they flourish inland. Crows are there for the same purpose, and shore birds such as the turnstone work in busy parties, turning the weed in search of small invertebrates.

Forming a new habitat If the strandline is cast high enough on the beach the seaweed humus–a rich fertiliser–with its accompanying moisture may make it possible for sea-beet seeds to germinate and flourish among the otherwise sterile shingle. Also, sea holly and common seablite often grow from the shingle in a line which marks an earlier strandline.

A strandline of weed deposited to rot on a sandy beach may form the basis of a completely new habitat–sand dunes. Blown sand transported by the wind will fall when it meets an obstacle such as a ridge of weed, and provided it is high on the beach, above the reach of ordinary high tides, such pioneer plants as sand couch grass and lyme grass (which grow rapidly with spreading rhizomes) soon begin to stabilise the sand. The succession which, if conditions are favourable, leads to mature dunes, may have been trig-



gered by the presence of a particular strandline.

These strandlines of the open coast can provide humus for growth of land plants, but on the estuary beaches, where strandlines are just as much in evidence, they often play a more significant role. The high spring tides of autumn bring in many seeds and concentrate them in lines at the very top of the beaches where such plants as sea-beet and oraches sprout in the spring. Seeds and debris form strandlines across saltmarshes, too, and if not destined to grow there, they at least provide sustenance for a wide variety of ducks and land birds in the harsh winter months when food is difficult to find.

Above: The egg case of a lesser spotted dogfish. You may find these cases both empty and still occupied on the strandline.

Right: Some of the more exotic strandline treasures – floats from Portuguese Men-o'-War. They look just like small blue plastic discs.

Below: Southerness beach – the strandline on this sandy shore is disfigured by man-made rubbish among the organic debris.

HEATHLAND DARTFORD WARBLERS

The Dartford warbler is the only British bird that lives exclusively on heathland. This fact alone places it among our most endangered species.

Much has been written in recent years of the disappearance of our southern lowland heathland, its specialist reptile inhabitants – the smooth snake and the sand lizard – and its one specialist bird, the Dartford warbler. The Dartford warbler is a true specialist, entirely dependent on these low heaths dominated by gorse and a mixture of heathers (usually ling and bell heather or sometimes cross-leaved heath). It is the dense cover provided by these plant species, as well as the unique invertebrate fauna of the heaths, that the bird needs for its survival.

Other bird species occur as close neighbours of the Dartford warbler on the heaths, including the stonechat, the grasshopper warbler, the whitethroat, the hobby and the nightjar, but apart from the resident stonechat all these others are annual visitors coming from the south to breed in the warmth and plenty of our temperate summer. These birds thrive on the shrinking heathland but, unlike the Dartford warbler, each can also prosper in other habitats. If the heathlands disappear completely or become too fragmented, the Dartford warbler must inevitably vanish with them.

The first recorded description of the Dartford warbler was based on two individual birds shot in 1733 on Bexley Heath (now known as Bexleyheath, and a far cry from heathland for it is today a populated suburban district) near Dartford in Kent. At that time similar heathlands spread extensively across lowland England, and the warbler had a range extending from Cornwall to Norfolk and from the Isle of Wight as far north as Shropshire and Staffordshire. Today, only a residual population exists on remnant heathland in Hampshire and Dorset, with unsteady outposts in Devon, the Isle of Wight, Surrey and Sussex.

Hard winters It seems clear that the Dartford warbler has always been subject to fluctuations in its fortunes, certainly so far as total numbers are concerned, even in times when its heathland home was far more extensive than it is now. Hard winters, in particular, take a heavy toll on this small insectivorous bird: after the severe and protracted winter of 1962-63 the population crashed from about 460 pairs to a mere 11. Its powers of recovery, however, are shown by the fact that by 1970 the numbers had picked up again to about 70 pairs, and then climbed to 560 pairs by 1974. Then the hard winter of 1981-82 reduced the numbers again, to perhaps half the previous summer's total.

On individual heaths, the density of Dartford warblers is inconsistent and often erratic; frequently the bird is numerous in one area, but scarce in another that was previously favoured and held good numbers. Uncontrolled fire is a serious factor in reducing the population, as in the dry summer of 1976 when severe heath fires destroyed many hundreds of acres of deep, mature gorse and heather; the damage was temporary in some areas, but permanent in others where reclamation of the ground for agriculture followed the burning.

A hidden bird The Dartford warbler is a shy and elusive bird, in many respects the archetypal skulking warbler, moving through thick cover with utmost ease and all too easily avoiding detection. On bright days it may show itself more readily, giving quick glimpses of its distinctive cock-tailed form before diving again into thick cover. Its appearances in the open are fleeting, and any obligatory movement from thicket to thicket involves only low darting crossings of open areas.

When glimpsed in the open there is no con-

Above: The upperparts are grey-brown, more slate-grey on the head, and the underparts a dull pinkish chestnut. Brightest among the bird's features is the reddish-orange eye ring, which gives the eye an unusual impression of size and a quality of penetrating brightness.

Below: In Britain the Dartford warbler is at the northern edge of its world range, which reaches south to the Mediterranean and North Africa.

fusing this diminutive bird with any other on the British list. Its small body size is equalled by the exceptionally long tail, which makes up half the total 12.5cm (5in) length. It weighs a mere 9-10 grams ($\frac{1}{3}$oz). The tail, characteristically cocked and frequently flicked, gives the bird much of its unmistakable outline, the remaining impression being of a dark coloured bird with small, rounded body, fine bill and a high forehead and crown. Its large reddish eye ring is immediately noticeable.

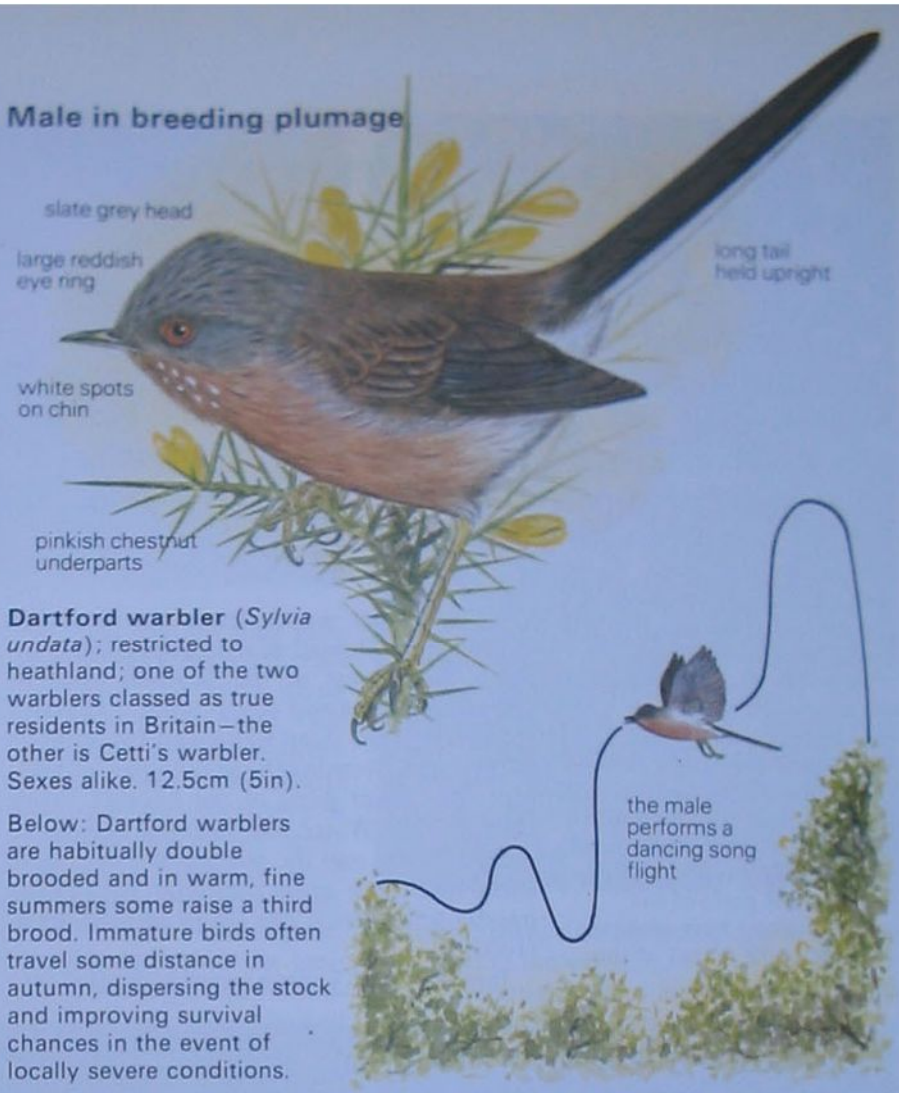
Displaying in April For a short period in early April, the cock birds are briefly conspicuous as they advertise their territory and sing. They have a lively dancing display flight in which the male bird rises above the dense canopy of gorse or heather and flutters down on vibrating wings. This display is reminiscent of that of a whitethroat, although it is neither as elevated nor as abandoned. The short, musical song also is similar to that of the whitethroat, but more mellow and liquid. The song is delivered from deep inside the gorse, or in a brief excursion to the topmost swaying twigs of a bush. Sometimes it is performed as an accompaniment to the dancing song flight.

Dartford warblers, sedentary throughout their range wherever they occur, are thus on site when the breeding season arrives and are among the early breeders. By mid April in a warm spring the first nests are built in the rank heather and gorse. The nest, although built by such a small bird, is remarkably robust, outlined first with twigs of heather and grasses and then shaped with finer grasses, rootlets and hairs, often woven with a little thistledown, wool or spiders' threads and individual feathers.

Three or four eggs are normally laid, dirty white in colour and finely spotted with lavender brown. The cock bird plays a small part in the incubation, which is chiefly carried out by the hen. The eggs hatch within a fortnight of the start of incubation.

Winter's shortage Very few species of wholly insectivorous small birds have evolved a sufficiently sound strategy to survive the vagaries of a British winter with reliability. The Dartford warbler faces no serious hardships in spring and summer, when the heathlands throb with the volume of insect life and the birds find an easy living. They have a ready harvest of small beetles, spiders, midges, small butterflies and moths, caterpillars and other larvae.

In winter, however, the choice narrows dramatically. The critical factor is the depth of cover provided by the heather and gorse. Deep under this canopy, even when it is covered with a thick layer of snow, the tangle of branches still provides a subsistence diet. Here the small warblers forage for heathland spiders, hibernating insects and the depleted stock of other invertebrates. In the hardest winters of all, shortages of these bring heavy losses to the Dartford warbler.


Male in breeding plumage
slate grey head
large reddish eye ring
white spots on chin
pinkish chestnut underparts
long tail held upright
the male performs a dancing song flight

Dartford warbler (*Sylvia undata*); restricted to heathland; one of the two warblers classed as true residents in Britain—the other is Cetti's warbler. Sexes alike. 12.5cm (5in).

Below: Dartford warblers are habitually double brooded and in warm, fine summers some raise a third brood. Immature birds often travel some distance in autumn, dispersing the stock and improving survival chances in the event of locally severe conditions.

THE JUNIPERS OF TYNRON

In south-west Scotland on the side of a valley lies Britain's finest example of a juniper wood – Tynron. Still privately owned, though now a National Nature Reserve, Tynron demonstrates how Britain's declining juniper stands might be rejuvenated.

Below: A view of Tynron juniper wood, looking eastwards towards the Shinnel Water. The junipers are a remnant of a larger stand that used to occupy the hillside but grazing by sheep and the clearance of some areas for planting reduced the wood to its present distribution around the steepest parts of the hill. The wood now covers some 5ha (12 acres) of the hillside.

Tynron juniper wood lies in the beautiful valley of the Shinnel Water, about 25km (15 miles) north-west of the Scottish town of Dumfries. The wood covers some 5 hectares (12 acres) of the steep south-east facing slope of the valley, forming the eastern part of Ford Hill. The lower parts of the Shinnel Valley towards the Water are devoted largely to dairy farming and the rearing of stock. Both sheep and cattle graze the rough tops of the nearby hills, which rise up to around 300m (1000ft).

Into the wood Tynron wood is divided into two main sections, separated by a broad heather-covered ride. The smaller section, which is to the west, has juniper as an understorey shaded by scattered broad-leaved trees, of which ash and gean (wild cherry) are the most numerous. Over the larger, eastern section of the wood the junipers are completely dominant, with only a few broad-leaved trees breaking up their dark green mantle.

The density of trees in the wood reaches up to 5000 per hectare (2000 per acre), with an average over the whole wood of perhaps half this figure. This is remarkably high for Scotland, where juniper usually occurs as an understorey in forests of Scots pine and birch, or as scattered bushes on grazed hillsides.

The junipers in the wood occur in both columnar and bushy forms. The columnar specimens reach heights of 7m (23ft), which is exceptionally tall for a juniper and is due to the Tynron site being well sheltered from the prevailing south-westerly winds. The majority of the bushy forms are 2-4m (6-12ft) high and a few are prostrate, growing along the ground. Because of the variety of forms, the canopy is very irregular and open, but dense impenetrable patches of juniper do occur over areas of a few square metres.

Tynron flora and fauna Apart from the

Above: One of the more interesting but rarer birds to be found in the wood – the crossbill.

Opposite right: Greater stitchwort with bluebells, two of Tynron's most common spring-flowering plants.

Below right: Looking north-west up the hill, with the flowering geans contrasting effectively with the dark green of the junipers.

junipers themselves, and the ash and gean already mentioned, there are a few small oaks and sycamores growing in the wood, along with bushes of elder, rowan and hazel. One stocky yew – like the juniper a native conifer – stands beside the main ride. Bracken and bramble dominate the ground community in the main stand of juniper, but on the upper slopes and on the main ride heather is mixed with a grassy sward of common bent grass, wavy hair-grass and sweet vernal-grass. Honeysuckle commonly trails over the juniper, and wood sorrel, wood sage, hairy wood-rush, broad buckler fern, primrose, bluebell and stitchwort are all common in the wood. In the dense shade created by some of the junipers, a moss community covers the ground and more than 20 different species have been recorded at Tynron.

The junipers of Tynron support three species of moth whose caterpillars feed specifically on this plant – the juniper pug moth, the Edinburgh pug moth and the juniper carpet moth. In Britain, all three moths are largely restricted to areas where junipers grow because of their dependence on the caterpillars' food.

Among the mammals, rabbits and hares have an important and detrimental effect on the juniper seedlings, which they sometimes damage or destroy by their grazing. Roe deer, badgers, foxes and hedgehogs have all been recorded in the wood.

The Shinnel Valley, in common with the other local valleys, attracts a wide range of breeding birds and many are to be found at Tynron, although none of the species is specific to a juniper habitat. Buzzards frequently soar over nearby Ford Hill, and sparrowhawks, which are as common in Dumfries and Galloway as anywhere in Britain, often leave their pluckings beneath the post of a fence. Siskins have been known to nest in the junipers and goldcrests annually sing there and almost certainly nest. The wood supports five species of tits, including the willow tit – a scarce species in Scotland. The commonest of the five is the coal tit.

Tynron's history Counts of the annual rings of junipers have indicated that the existing specimens are no more than 150 years old,

Above: Juniper berries take two years to mature, remaining green for the first year and ripening to become dark purple during the second.

Left: A juniper carpet moth, one of three British species of moth whose caterpillars feed exclusively on juniper leaves.

Below: Young juniper, indicated by white markers, growing in front of mature bushes.

with many of the largest bushes in the age-range 80 to 120 years. Juniper is a slow-growing plant and even quite small bushes can be older than 100 years, especially those growing on more exposed sites.

The origins of the junipers are obscure and the earliest record of their existence on the site dates back only to the later 19th century. However, it is believed that the junipers growing there today are the descendants of an earlier juniper scrub.

All that is known for certain is that the present stand of junipers is a remnant of an area of about 20 hectares (50 acres) which existed at the beginning of this century. This larger area was gradually cleared by the landowner to provide extra grazing for his livestock and to establish a small conifer plantation. The remaining junipers probably owe their survival to the steepness of the rocky hill on which they are growing, the land being generally too steep for any practical purpose.

Junipers used to be more widely distributed in Scotland but they have been reduced in numbers, or even eliminated, in many areas by the burning and clearing of land for sheep grazing and the subsequent grazing by these animals of any regenerating junipers.

Present management The wood is still privately owned but in 1957, with the helpful co-operation of the landowner, Mr James Gourlay and his family, the Nature Conservancy Council negotiated a lease of the

Left: It is not unusual for a roe buck to jump the boundary fence to the reserve and hide up by day among the stands of juniper.

Right: The majority of junipers in Tynron form small bushes no more than 4m (13ft) high, but a few have a columnar habit of growth and reach heights of up to 7m (23ft), which is exceptionally tall for this species.

Below: To reach Tynron reserve, take the A702 heading south-west from Thornhill, which lies on the A76. After about 7km (4 miles) you suddenly come upon a swathe of dark green juniper across the hillside on the right, just before the road bends over the picturesque Shinnel Water. Excellent views of the reserve can be had from this road.
Do not forget that the reserve is private land, though visits can be arranged through the regional office of the NCC.

area, and the following year it was declared a National Nature Reserve.

Since then, management of the reserve has been directed towards the perpetuation of the junipers, the first act being to erect a boundary fence to exclude cattle, which had previously grazed among the juniper bushes. A small area of juniper remains outside the boundary of the reserve, where pressure of grazing is preventing regeneration. Some selected clearance of bramble, rose and bracken, and the saplings and suckers of deciduous trees, has been undertaken, mainly to help prevent the juniper stand being colonized by taller trees and also as a possible means of encouraging junipers to regenerate. The numbers of rabbits and hares have been controlled from time to time, to minimise the damage their grazing causes to juniper seedlings.

Apart from conserving a splendid example of juniper scrub, the National Nature Reserve was created because of its potential for research and study. During the 1960s and 1970s, several studies were carried out into such subjects as the soils of the reserve, the age of individual trees, the rate at which their girths increase and the regeneration of junipers. Regeneration was found to be poor–except on one area where a serious fire broke out in 1959.

The fire of 1959 In September 1959 an accidental fire destroyed almost a hectare (2 acres) of juniper on the higher slopes of the reserve. The fire started while cut bracken was burned. Over the next three years hundreds of juniper seedlings appeared on the burnt area and it became clear that the fire had precipitated the best regeneration of juniper seen at Tynron for many years. It seems very likely that juniper scrub does depend to a great degree on fire for its regeneration. This may well have a bearing on the decline of juniper in parts of southern England, where a lack of fires means that there are only old bushes with little or no regeneration. The use of fire on carefully selected parts of these sites to stimulate regeneration would seem to be a most promising management technique for the future.

NOCTURNAL ASSASSINS

Once described by the great French entomologist Fabre as 'frenzied murderers of the insect world', ground-beetles are well-equipped for hunting through the night.

Ground-beetles belong to the same family (Carabidae) as tiger-beetles. Although both groups are predators, tiger-beetles hunt in the daylight while ground-beetles are very much creatures of the dark. The majority of ground-beetles restrict their activities to soil level, lurking under stones or leaf litter during the daytime. They are all efficient hunters, being equipped with long legs, large sharp jaws and long sensitive antennae.

In size ground-beetles range from a few millimetres to about 3cm (1in) long. Most species are a drab colour – normally black – and often have a metallic iridescence which results from the scattered reflection of light from the irregular surfaces of their bodies. Many of the larger species have grooves or embossed raised dots and lines on their elytra.

Relentless killers Ground-beetles consume a wide variety of invertebrates, including woodlice, snails, slugs, worms, and many insects. Aided by their sharp, pointed mandibles which are notched on the inner surface, they capture and retain the most slippery of prey, even though it is often many times their own size. Some species, like the violet ground-beetle and *Carabus nemoralis*, are particularly active on mild wet evenings when earthworms are washed out of the soil.

Man is turning their predatory nature to his advantage by using those that feed on moth larvae (which damage trees) for biological pest control.

Fierce young Ground-beetle larvae, which develop from eggs laid in the soil or rotten wood, are as predatory as their parents. They have either soft white or hard shiny black bodies, and are found in the upper part of the soil – you may accidentally dig one up in the garden – or in shelters below ground-level such as cellars or bunkers. Using their senses of touch and smell when searching for prey, they are slower-moving than adult ground-beetles but still highly effective hunters.

Pupation takes place in an earthy cell in the summer. The pupae are white and lie on their backs, supported by small tufts of dorsal bristles. The emergent adults may hibernate during the winter although, in times of severe drought, some species, including *Carabus*

Above: The violet ground-beetle (*Carabus violaceus*) is 3.5cm (1⅓in) long and has a purple flush along the edge of its elytra.

Right: When threatened by a predator, the bombardier beetle (*Brachinus crepitans*) gives off spectacular explosions.

Below: This handsome ground-beetle, *Carabus granulatus*, is often found in groups hibernating beneath the bark of dead trees.

nemoralis, undergo a summer resting period (aestivation) until more favourable conditions occur. In most species the life-cycle is completed within a year, although some may take longer.

Explosive defence systems The secretive habits of ground-beetles and the speed at which they can move help to protect them from potential predators, but most species have additional means of defence. In some cases this is purely passive–*Broscus cephalotes*, when threatened, feigns death by lying inert with its legs and mandibles extended.

In other cases they are more offensive; *Carabus granulatus* is one of a number of beetles which exude an unpleasant fluid from the mouth that instantly deters predators. Some species forcibly discharge fluid from a pair of glands which open on either side of the anus.

By far the most impressive ground-beetle defence is employed by the bombardier beetle which, despite its fame, has only a local distribution in the chalky regions of southern England. The beetle releases repellent substances as a vapourising spray, following a minor explosion within its body. Since this spray has an effect on human skin similar to that of nitric acid, and the beetle is capable of a succession of shots, it is not surprising that such a small species can deter predators larger than itself.

A look at some species One of the best places to look for ground-beetles is the garden. Here you are most likely to come across some of the larger species, the violet ground-beetle, for example–a black shiny creature with a distinctive purple or violet flush along the edges of its elytra. *Carabus nemoralis* is nearly as large and has copper or green elytra.

The larger ground-beetles with more specialised habitats include the attractive *Carabus granulatus*, a dark bronze or metallic green beetle. Even more striking in appearance is *Carabus nitens*, a locally distributed species which is largely confined to damp moorland where it is found among sphagnum.

Some ground-beetles make their homes in burrows in damp ground, using their broadened forelegs for excavation. *Clivina fossor*, for example, tunnels in cow-pats.

Not all ground-beetles are nocturnal. The semi-aquatic *Elaphrus riparius*–one of the more common British species–is often seen in bright sunshine. It is similar to a miniature tiger-beetle in appearance and has distinctive indentations on its elytra.

Above: Unlike most ground-beetles, *Elaphrus riparius* is active during the daytime, when it uses its particularly large eyes for hunting. It is a semi-aquatic species often found in the sunshine on sandy edges of ponds.

Below: Most ground-beetles are well-equipped for nocturnal assassination, with long legs for running fast, sensitive antennae, and large, sharp jaws for catching and retaining prey.

Nocturnal hunters

Above: *Carabus nemoralis* and larva. Length of adult 2.5cm (1in), copper or green elytra with 3 rows of pits.

Above: *Clivina fossor*. Length 5-6mm ($\frac{1}{4}$in), black or dark brown, with front legs adapted for digging.

Left: *Carabus nitens*. Length 2.5cm (1in), metallic green elytra with coppery-red thorax and head.

Right: *Notiophilus biguttatus*. Length 5-6mm ($\frac{1}{4}$in), dark bronze-brown with large eyes.

Above: *Elaphrus riparius*. Length 6-7mm ($\frac{1}{4}$in), bronze-green elytra with rows of eye-like spots.

Above: *Broscus cephalotes*. Length 1.5-2cm ($\frac{1}{2}$-$\frac{3}{4}$in), black all over with large head and broad thorax.

GREGARIOUS DOLPHINS: MAN'S FRIEND AT SEA

Dolphins have long symbolised friendliness and intelligence. Some, such as the common dolphin, take pleasure in riding the bow waves of boats, at the same time giving us an excellent opportunity to watch them at close quarters. Many routinely follow ferries, either in herds or alone.

Below: Common dolphins. Dolphins are highly gregarious, living in social groups and using their combined sensory abilities to hunt and herd fish and evade predators, notably sharks and killer whales. Such species as the bottle-nosed dolphin form groups of 3-15 individuals in coastal waters and search for shoaling fish together, as well as feeding alone. They communicate by ultra-sonic clicks, vocalisations and tail-smacking.

Dolphins and porpoises are members of the whale sub-order Odontoceti, the so-called toothed whales, such as the killer, sperm and beaked whales. They can usually be distinguished from other toothed whales by their small size, the largest dolphin being no more than 4m (13ft) long. In British waters five species are commonly seen – white-beaked, white-sided, bottle-nosed, common and Risso's dolphins. The harbour porpoise is the only porpoise found in British waters. It is distinguished from its larger dolphin relatives by its small triangular dorsal fin (the dorsal fin of dolphins curves backwards), its spade-like teeth (dolphins generally have conical teeth), and by its smaller size – it is only 1.2m (4ft) long.

Links with man Ever since the writers of classical Greece dolphins have figured highly in the culture of man. Greek legends tell of Arion, the wandering minstrel who travelled widely, playing his music and saving his earnings. The crew of a ship taking him home set upon him to steal his money. His final request was to play his lute for the last time. As he played, dolphins swam to the ship, whereupon he jumped overboard and one of the dolphins bore him on its back safely to the shore. This is only one of many similar tales, a present-day example being Horace Dobbs' account of his own son being carried by Donald, a bottle-nosed dolphin off the British coast.

This type of activity may be connected with the care-giving behaviour between dolphins. Herd members help a mother to raise a newborn calf to the surface for its first breath, and an injured dolphin is often helped in a similar way. It is partly this kind of response that has led man to consider dolphins to be highly intelligent, altruistic behaviour tending to be regarded as primarily a human feature.

Clearly, dolphins learn tricks fast in dolphinaria, and they appear inventive and quick to imitate. However, it is difficult to assess how intelligent they are. The problem in comparing them with man is that dolphins live in a medium where different senses have different relative importance from those used by man. For example, dolphins can hear noises of a wider frequency range than man.

Dolphins live in social groups and cooperate to find food and other dolphins. When in the open ocean, groups are generally larger and move over greater distances than those closer inshore. The larger aggregations may be due in part to the need to provide better protection against rare predator species, notably the killer whale, out in mid-ocean. Larger groups are probably more effective in navigation and food-finding, using their collective experience.

Communication With such a gregarious existence good communication between individuals and groups is important. Dolphins have a rich repertoire of vocalisations and actions, ranging from echolocatory clicks to squeaks and squeals. Different sounds are produced at different levels of excitement, and dolphins in a group constantly seem to be emitting calls which may keep the group together in the same way as contact calls made by birds in flocks.

Although the food source of dolphins tends to be patchily distributed, it is often abundant. It has been estimated that dolphins require between four and ten per cent of their body weight in fish daily – about five to ten fish of mackerel or herring size. Thus it is likely that there is much time for social interactions.

In most species group membership seems to be fairly fluid, comprising both males and females. There is usually one annual calving peak, although in some species, such as the bottle-nosed, courtship occurs throughout the year, possibly because it enables individuals to determine their status in relation to each other, and hence the dominance hierarchies in the group. The bond between mother and calf is strong, and the calf may remain with her for many months. However,

Above: A beached harbour porpoise. In the past it was common to see small herds of porpoises around such resorts as Brighton and Blackpool, but recently these have become much less frequent. Porpoises are quite difficult to observe: they rarely do more than skim the surface, their small fins or arched backs being all that you tend to see.

Below: Common dolphins in rough seas. This is the dolphin most often seen in the Channel approaches, off southern Ireland and western France, and it often occurs in large herds.

Above: The white-sided dolphin, like its close relative the white-beaked dolphin, may commonly be seen in the Minches of west Scotland, and in Orkney and Shetland waters. It generally moves in large schools.

Below: The common dolphin is slender and graceful. Only the harbour porpoise is more frequently stranded around the British coast.

the bond between adult male and female is apparently weak, and mating seems to be fairly promiscuous. Unlike other dolphin species, Risso's dolphin is probably polygamous, with one male having a harem of females.

British dolphins Much of our information about dolphins is based on information from stranded dolphins around our coasts. It is supplemented by data from live sightings by numerous observers, but there is still much to learn. The bottle-nosed dolphin, once the commonest dolphin in the stranding records, has clearly undergone a decline in recent years in British and European waters. It is an inshore species of sheltered bays and estuaries. Here it is particularly susceptible to pollutants such as heavy metals and pesticides and these, together with the pressure of overfishing of its food prey (such species as cod, herring and halibut) in such areas as the southern North Sea and the Channel, may be responsible for its decline. The greater disturbance from vessels in these inshore waters may also have played a part.

The same influences may have contributed to the apparent decline in the harbour porpoise, although it is still probably the commonest of these species around our coast. White-beaked dolphins, on the other hand, seem to be benefiting from the large numbers of mackerel off north-west Britain in areas once frequented by great shoals of herring.

The white-sided and the white-beaked dolphins both have a more northerly distribution, and further south they tend to be replaced by the common dolphin. This species often occurs in large herds, usually away from the coast where it catches fast-moving shoaling small fishes such as sardine and anchovy.

Although the white-sided and white-beaked dolphins tend to be restricted to the cooler waters of the north Atlantic, the common dolphin is distributed world-wide, from warm temperate regions to the tropics. It is one of the commonest species in the Mediterranean, sharing these comparatively sheltered and warm seas with the euphrosyne dolphin, which it closely resembles. The euphrosyne

dolphin occurs off the French coast, and rarely off south-west Britain where there have been strandings and two sightings in recent years.

Risso's dolphin also tends to occur in warmer waters, although it is not uncommon along the west coast of Britain and Ireland. Here it is much more of an inshore species and may even be seen from headlands, such as Tiumpan Head near Stornoway in the Isle of Lewis.

Some dolphins, such as the common and euphrosyne dolphins, often come to the head of a boat and ride the bow wave. They use the push provided by the wave by angling their tails against it and riding under water, rather as humans do when surfing on waves above water. Besides the advantage of moving forward and saving their energy, dolphins seem to engage in this behaviour simply for pleasure. 'Pelorus Jack,' a famous Risso's dolphin in New Zealand, regularly accompanied ships through the narrows of the Marlborough Sound in the early part of this century.

There are no freshwater dolphins in the British Isles, although a few species live in such rivers as the Amazon and Plate of South America, and the Ganges of India and Pakistan. However, habitat changes and pollution may all have contributed to the decline of some of these species, some of which are now threatened with extinction.

Above: The dolphins and harbour porpoise of the British Isles. When searching for dolphins, look out for distant splashing as the animals break the surface of the water. This behaviour is probably for panicking and then driving fish. It may also alert other dolphins, organise the herd for more effective food capture and help in navigation, as well as provide sheer enjoyment.

Where to see whales, dolphins and porpoises in British and Irish waters

Many species of whales and dolphins occur around our coasts. The large whales are generally here only during summer, having migrated northwards in spring from warmer water near the equator, where they go to mate or calve. The smaller whales and dolphins do not undergo such extensive migrations, although they tend to move away from the coasts, and sometimes southwards, in autumn. British waters become so rich in these species in summer because of the high productivity in the seas at this time which provides food for swarms of plankton, which in turn are eaten by many fishes and cephalopods (squid). All these fall prey to seabirds, and to whales and dolphins.

sperm whale

pilot whale

common dolphin

Aberdeen
Glasgow
Edinburgh
Belfast
Dublin
Liverpool
Lincoln
Cardiff
London
Southampton

A bottle-nosed dolphin, common porpoise
B common dolphin
C white-beaked dolphin
D white-sided and white-beaked dolphins
E Risso's dolphin
F fin whale and minke whales
G minke whale
H humpback, right whales
I sperm whale
J killer whale
K pilot whale

THE MESPIL: SNOW IN APRIL

There are few more impressive sights during the month of April than a snowy mespil completely covered with its pure snow-white flowers. Yet this beautiful tree is causing much controversy among botanists arguing over its correct name.

Below: Snowy mespils in flower. As well as being a popular garden tree, this species is now naturalised in some parts of the country, mainly on sandy heaths and the occasional railway embankment in southern Britain.

The snowy mespil belongs to the genus *Amelanchier* in the rose family. At one time the various species of snowy mespil (for there are 25 species world-wide) were included in the same genus as the medlar, whose Latin name, *Mespilus germanica*, probably accounts for the snowy mespil's common name. At other times the snowy mespils have been included with the pears and with the hawthorns, but they are now considered to form a separate genus.

In general, *Amelanchier* is a small genus of deciduous shrubs and small trees. Their leaves are always toothed at the edges and are arranged alternately along the twigs. The flowers resemble those of apples and plums but they are usually borne on elongated heads and the petals tend to be rather narrower.

Garden mespil The snowy mespil is one of our most popular ornamental garden trees and has been grown in gardens for more than 200 years, being introduced to Europe probably from Canada. However, there is some uncertainty over this because there are no wild North American species quite like the plants in cultivation in this country.

The garden snowy mespil grows to a height of about 9m (30ft) and has a smooth, dark grey bark. The flowers are borne in heads of about eight to ten and appear from the middle of April to early May, lasting for just a week. They are usually pure white, though one cultivar occasionally seen in gardens has

Amelanchier ovalis

Snowy mespil *(Amelanchier lamarkii)*

flowers tinged with pink.

The flowers appear at about the same time as the young foliage starts to unfurl an attractive coppery-pink. With maturity the leaves become green and up to about 8cm (3in) long. In the autumn the leaves turn a spectacular series of colours, gradually changing through ever-deepening shades of yellow and orange to scarlet.

The blackish-purple fruits are quite sweet and juicy when ripe and are soon stripped from the tree by birds.

Escape to the wild The same species of snowy mespil planted in gardens has become naturalised in several areas of Britain, growing quite extensively on sandy heaths and on the occasional railway embankment of southern counties. The plants were probably introduced there from garden specimens by birds feeding on the seeds.

The snowy mespil is also found naturalised in other parts of Europe, including France, Germany, the Netherlands and Belgium. In Germany and the Netherlands the tree was once cultivated for its fruits, rather than for its ornamental qualities.

New name The Latin name of the snowy mespil grown in British gardens and naturalised here has caused some confusion and controversy over the years. At least three different Latin names have been ascribed to it, according to how the particular author believes the species originated.

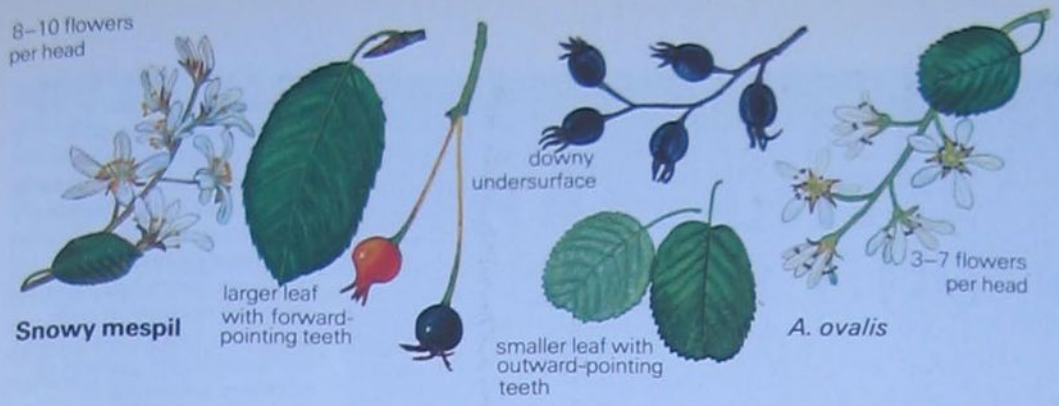
Above: *Amelanchier ovalis* is a shrubbier version of its close relative, the snowy mespil. Its flowers appear slightly after the leaves and are similar to those of the snowy mespil, except that there are fewer on the flower heads, which are always borne upright on the tree.

Until recently the snowy mespil was believed by many people to be the same species as a tree known as the Allegheny serviceberry (*Amelanchier laevis*), which is native to the eastern parts of Canada and the United States. But there are good grounds for regarding the two species as being different species. For example, the leaves of the snowy mespil are only just developing during the flowering period and have a purple-tinged silky down. On the Allegheny serviceberry, on the other hand, the leaves are fully expanded at flowering time and are green and almost totally devoid of hairs.

Because of this and other less obvious differences, the snowy mespil has been treated as a distinct species in a recent account, the author maintaining that this was the only practicable solution to the problem of what to name it. It was given the name *Amelanchier lamarkii*.

Another source of confusion concerns the plant's common name. While some respected authorities refer to its as the snowy mespil (as we do here), others insist that it should be called snowy mespilus, serviceberry, june berry, shad berry or some other name.

Other people regard the name snowy mespil as applying only to a native European species of *Amelanchier* and not at all to the cultivated tree grown in gardens. Against this, some maintain that the name only applies to the



Left: Our two most common species of *Amelanchier*, the snowy mespil which forms a small tree and is naturalised in Britain, and *A. ovalis*, which is most often seen as a many-stemmed shrub though it may grow to become a tree.

Snowy mespil (*Amelanchier lamarkii*). Deciduous tree, native probably to North America and introduced here during the 18th century. Height to 9m (30ft).

Amelanchier ovalis. Deciduous shrub or tree, native to southern and central Europe. Height to 3m (10ft) in the wild, 5m (16ft) in cultivation.

garden tree, which is definitely not native to Europe. This article regards snowy mespil (*Amelanchier lamarkii*) as being the tree grown in cultivation in Britain and sometimes found growing wild here.

Native European The reference to a native European species of *Amelanchier* in the above paragraph is to a species quite distinct from the snowy mespil of gardens, though it too is called snowy mespil in some books. The plant is *Amelanchier ovalis* and it grows wild in southern and central Europe, reaching as far north as Luxembourg and southern Poland. It is not native to Britain, but it is fairly frequently grown here as an ornamental.

In the wild, *A. ovalis* is usually found in rocky limestone areas of mountainous regions, though it sometimes occurs in open woodland. Its typical habit is as a many-stemmed shrub, though it may grow to become a small tree reaching 3m (10ft) in the wild; cultivated specimens may grow to a height of 5m (16ft).

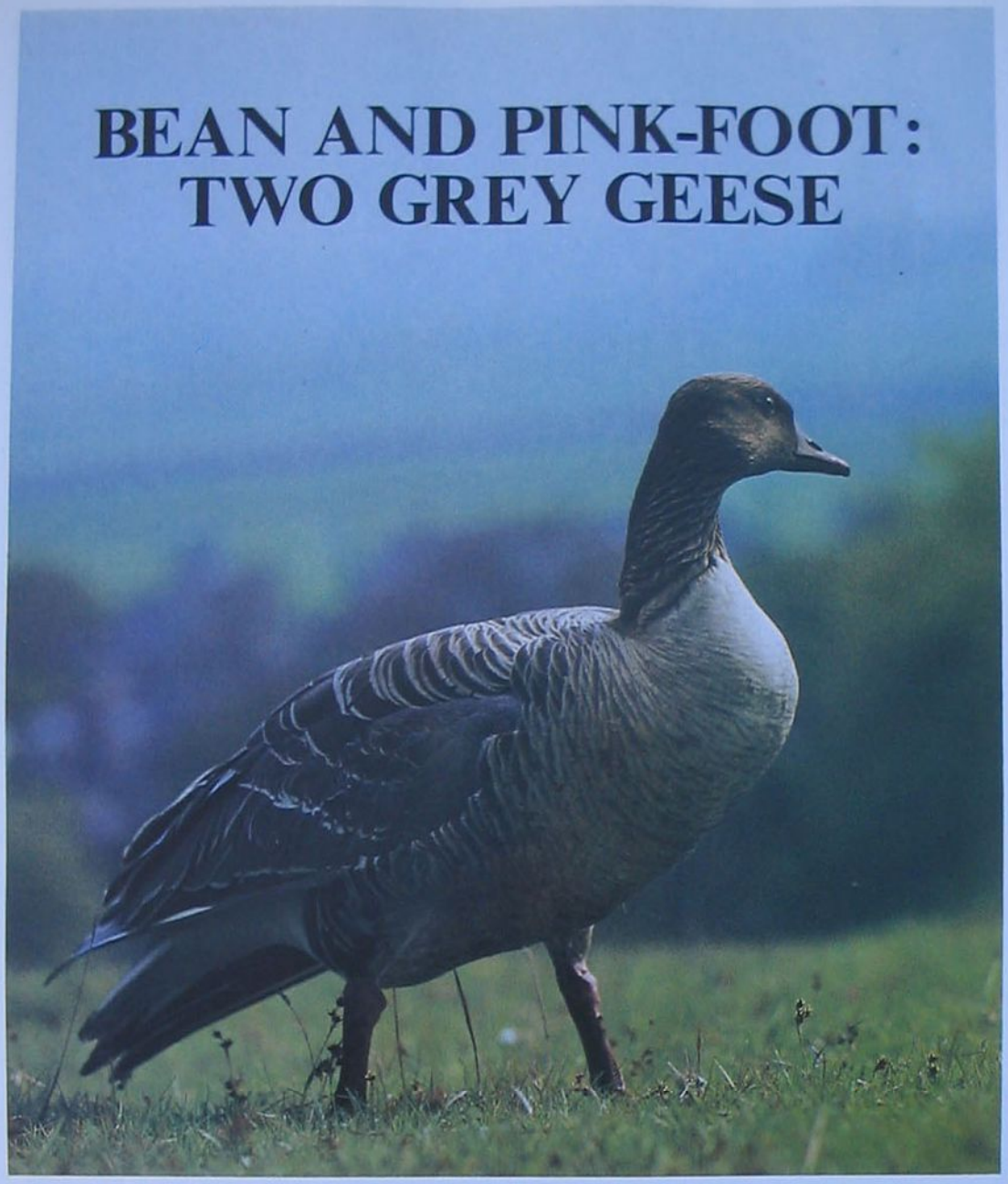
The two species, *A. ovalis* and *A. lamarkii*, are most easily told apart by the leaves. Those of the former tend to be much rounder than those of the latter, have downy undersurfaces and are much smaller – 2.5-5cm (1-2in) long against 3-7cm ($1\frac{1}{4}$-$2\frac{3}{4}$in) long. It is quite easy to distinguish the two species just by the pattern of the teeth on the leaf-margins. *A. ovalis* has slightly coarser teeth, which point straight out from the margin, while the teeth of *A. lamarkii* are finer and point towards the leaf apex.

Unlike the snowy mespil, *A. ovalis* has never become naturalised in Britain, but it is widely planted in gardens.

Above: Snowy mespil in blossom. The flowers usually last just a week, appearing at any time from the middle of April to early May. They are fragrant with five pure white petals (though one cultivated variety has flowers tinged with pink). While the flowers are out the leaves begin to emerge, unfurling an attractive coppery-pink before turning green.

Far left: Its spring display of blossom makes the snowy mespil one of our most attractive trees early in the year. But it also becomes extremely pretty in the autumn, as shown by this picture of the same tree taken later in the year (left). The leaves gradually change colour through shades of deep yellow, then orange to become scarlet.

BEAN AND PINK-FOOT: TWO GREY GEESE



Left: A pink-footed goose in its feeding grounds. In the 1960s most of our pink-footed geese wintered in Scotland, and at one time it looked as if most English haunts would become completely deserted. However, there has been a dramatic reversal of this pattern in recent years, with the spectacular growth of numbers wintering in Lancashire and Merseyside. On the rich flat farmland behind the coastal resorts of Southport and Formby, north of Liverpool, the geese can find abundant barley stubble and potato fields; they also make the occasional foray after carrots. From around 5000-7000 using this region in the early 1970s, the numbers had risen by 1982 with its cold weather in January to over 30,000.

Pink-footed goose (*Anser brachyrhynchus*). Winter visitor; feeds on farmland; roosts on mudflats, estuaries and inland. Sexes alike. 60-76cm (24-30in).

Bean goose (*Anser fabalis*). Winter visitor; feeds on farmland; roosts on mudflats, estuaries and inland. Sexes alike. 70-89cm (28-39in).

Below: A bean goose walking on ice. Two flocks are found in Britain.

Only a few hundred of the world's 200,000 bean geese visit Britain, but 90,000 pink-footed geese appear at the roosting sites in England and Scotland every winter. Both species feed partly on farm crops, the pink-foot helping to clear away any potatoes that have been left behind by the harvesting machines.

The pink-footed and bean geese both belong to the group known as the grey geese, separating them from the black geese, such as the barnacle and Brent. Other grey geese include the greylag and the white-front. They are closely related species—indeed, some authorities regard the pink-foot as merely the westernmost subspecies of the bean goose. The main differences between them are that the pink-footed goose has pink legs and feet, and a narrow pink band across its black bill, while the bean goose has orange legs and feet, and a varying amount of orange on its black bill.

Superficially their plumage is the same—grey-brown on the back, paler brown underneath, with a darker brown head and neck. However, the pink-foot is a much greyer bird than the bean goose, particularly on the back, and is smaller and with a shorter neck and wings. The undertail coverts of both species are white, as is the rump. In flight the bean goose, as well as having a longer neck, has longer, narrower wings. Both species have a 'wink-wink' call, but the pink-foot's is pitched much higher.

Habitat and food Both pink-footed and bean geese feed principally on farmland. Indeed, the bean goose gained its name centuries ago for its habit of gleaning spilt beans on fields after the harvest, especially on the Continent where this was a common crop. Nowadays when the geese arrive in Europe in

autumn from their northern breeding grounds, they feed extensively in stubble fields of wheat and barley, picking up the grains missed by the combine harvesters. Pink-footed geese are also very fond of potatoes, moving on to the fields as soon as they have been harvested, and picking up the broken pieces and small potatoes which have not been gathered. They do the farmer a good turn by this action, cleaning the field and so reducing the risk of 'rogue' potatoes appearing the following year, and perhaps spreading disease.

Pink-footed geese have not always eaten potatoes. They seemed to learn about this food some time in the 1880s. The first instance of this behaviour took place in Lancashire about this time, and it was confined to that area for many years. From about the 1920s, though, it became more widespread and now occurs wherever pink-footed geese and potatoes are found in the same region. It is thought that the geese may have learned about potatoes as a food by seeing other birds feeding on them, especially mallard, though it is not known how long that species has eaten potatoes.

Late winter feeding The remnants of such harvested crops as barley and potatoes last the geese through autumn and into the early winter. Then they turn to grass and to sprouting winter wheat. As the winter progresses into spring, complaints are sometimes heard from farmers that the birds are causing damage, taking grass needed for sheep and cattle or, in wet weather, trampling the growing wheat. Such damage is generally very local in occurrence, and probably has only a marginal effect on the final yield, especially when compared with the normal hazards of farming, such as bad weather.

In parts of Lancashire the pink-footed geese learned to eat carrots a few years ago. First they fed on the waste left after harvesting, but then some geese started eating unharvested carrots. However, it was found to be quite simple to scare the geese away from vulnerable fields, and in recent years there have been no problems of carrot damage.

Right: A bean goose, recognisable by its orange and black bill. This orange colour, seen on the bill and the feet, is one of the main distinguishing features between the bean goose and the pink-foot. Bean geese are not common in Britain: apart from the two regular flocks, only a few scattered individuals arrive in the country; sometimes these belong to the Russian race; they are usually in flocks of other species of geese, such as the white-front. The bulk of western Europe's 100,000 bean geese winter in Germany, the Netherlands, France and Spain; and there are as many more in central and south-eastern Europe.

Two populations

The British pink-footed geese belong to the 'Icelandic' population (which breeds in both Iceland and Greenland). There is a completely separate population which breeds in Spitsbergen and winters on the Continent. Although the two groups are not far apart in winter, they do not mix.

breeding
wintering
--- divides winter ranges of Iceland and Spitsbergen populations

Roosting sites While the geese are content to feed on farmland, they must, in addition, have access to water for drinking and bathing, and also as a safer roost at night than dry land. Traditionally the geese used to roost on large estuaries and coastal mudbanks. Over the last 30 years or so they have increasingly moved inland, to reservoirs and large lakes. The main reason seems to be the amount of shooting that occurs on the coast, compared with the sanctuary often provided at inland waters. A limited amount of shooting can be tolerated by these wary birds, but if the disturbance becomes too great they move elsewhere.

Bean goose distribution Looking solely at Britain, the pink-footed goose is much the commoner of the two species, but in world

Above: A flock of pink-footed geese returning to their roosting site at dusk. The 'spearhead' can be seen at the front, but there are so many geese that it would not be practical for them all to fly in a V. Normally the birds feed throughout the day, unless disturbed, and do not return to roost until it is nearly dark. Then they 'flight' back (fly *en masse*) and circle down on to the water for a long drink, a bathe and much preening, before settling down for the night.

terms the bean goose predominates. Bean geese can be found breeding almost throughout the northern latitudes of Europe and Asia, from northern Scandinavia right across the Soviet Union to the Pacific coast. They inhabit both the Arctic tundra and the forested 'taiga' zone to the south. In both habitats they breed beside small pools and marshes.

Over such a vast range, it is not surprising that different populations have formed, with different migration routes and wintering areas. These in turn have led to the development of separate subspecies or races of bean geese–five in all. Three of them come nowhere near Britain or Europe, migrating to winter in India, China and Japan. The other two are the Russian bean goose, which breeds on the tundra, and the western bean goose, which breeds in the forested zone of the Soviet Union and also in northern Scandinavia. It is birds of this last race which winter in small numbers in Britain. Two regular flocks can be found: one in Norfolk, numbering about 300 birds, which has increased sharply in recent years; and the other, normally less than 50 birds, in Kirkcudbrightshire.

Pink-foot distribution The pink-foot is confined as a breeding species to the Arctic archipelago of Spitsbergen, 600km (400 miles) north of Norway, and to Iceland and east

Right: These pink-footed geese with their chicks are tame birds that do not migrate but live at Slimbridge, for they are inmates of the world's largest wildfowl collection, the Wildfowl Trust. As a wild species, the pink-foot breeds only in the Arctic archipelago of Spitsbergen, 600km (400 miles) north of Norway, and in Iceland and east Greenland. In all these places it breeds on the tundra, the open landscape of the Arctic plains.

Greenland. In all areas it breeds on the tundra. The birds of Spitsbergen are a self-contained population of between 25,000 and 30,000.

The British pink-foot population begins to arrive here from its breeding grounds in mid to late September, and all the birds are generally here by mid-October. They do not depart again until about the middle or end of April, or even into early May. The major wintering areas are in eastern and southern Scotland, and in Lancashire and Merseyside. Smaller numbers occur in the north of Scotland and in eastern England, on the Humber and around the Wash. In the 1950s the population was much smaller than it is now, with around 30,000 birds. During the late 1950s and through the 1960s numbers increased steadily, and though there has been some slackening in the rate of growth the population now totals about 90,000.

The main reasons for this three-fold increase seem to be the improved food supplies, and increased safety. Since the last war the acreages of barley and potatoes grown in Scotland have increased tremendously. Grassland has also been improved, with much more fertiliser being used. All these crops provide food for the pink-footed geese, and the better the food the better they are able to survive the winter, particularly the young ones. Furthermore, the adults return to their breeding places in the spring in good condition, capable of laying larger clutches of eggs and rearing more young.

Better safety for the geese has resulted at least partly through the change from roosting on the coastal sites, where shooting sometimes takes a heavy toll, to roosting inland on lakes and reservoirs, where shooting is limited.

The Ribble area Britain's population of pink-footed geese has grown throughout its area of distribution, but the area with the most dramatic rate of increase during the 1970s was the coastal plain of Lancashire and Merseyside. Roosting on the coastal sites on the Ribble Estuary, they feed inland on the rich, flat farmland behind the coastal resorts of Southport and Formby, north of Liverpool. Here they find abundant barley stubbles and potato fields.

Although there is some shooting on the coast, the geese have now begun to roost on the fields instead of the mudflats. Normally this would be suicidal behaviour, for the birds would be stalked wholesale–both by foxes and shooters. But in this area there are no foxes, and shooting is not permitted. Not only that, but the sky has an orange glow from the lights of the nearby towns; almost as bright as moonlight, this makes the geese feel able to detect danger, and so they are sufficiently at ease to roost. Not only have they long since learned to take advantage of man's farming activities, but they have now adapted to turn his technology to their benefit as well.

Wild geese of the British Isles

You can easily tell grey geese from black geese because they have less black in their plumage. Separating pink-footed and bean geese from the other grey geese is nearly as hard as separating them from each other. Fortunately, flocks tend to visit traditional haunts regularly, so a local knowledge of the population of geese is often helpful.

If you see geese in flight, both colour and shape can help. A greylag has very pale grey front halves to its wings, as well as a shorter neck with a large head and stout bill. A white-front is darker underneath (its name refers to its 'forehead') for the adult has black belly bars. Its wings are narrower.

Looking at pink-footed and bean geese, you can tell which are the males because they are a few inches larger–the plumage being identical. Young birds are a dull brown, with irregular markings instead of the whitish stripes.

WASP-LIKE CLEARWINGS

Clearwing moths are a fine example of insects which acquire protection from their enemies by mimicking other species that are distasteful, poisonous or have a sting.

The clearwings are an attractive group of moths belonging to the family Sesiidae. Of the 15 species which occur in the British Isles, five are particularly well known.

Moth mimicry As their common family name implies, all species have more or less transparent wings. Their bodies are slender, often ending in a tuft of hair, while their antennae are particularly conspicuous and thicken towards the tips. It is, however, their striking mimicry of other insects–notably wasps–that is their most remarkable feature. As edible insects they deter hungry birds from pursuing them by mimicking those insects that have some means of self defence, be it a sting or an unpleasant taste.

Life-cycle The life histories of all clearwings are basically similar. The females lay their eggs on the larval foodplant in summer. On hatching the caterpillars eat their way through the woody tissues of trees and bushes, forming galleries or galls depending on the species. The larval stage is long–two or three years–since the caterpillars must consume vast quantities to compensate for the low nutritional value of wood.

When ready to pupate, the caterpillars construct cocoons within their burrows, near the surface of the wood. The pupae are different from those of most other moths in that their legs are free instead of being encased with the rest of the body. Moreover, rows of spines protruding from the pupae enable them to force their way out of the cocoons, along the burrows and through the thin layer covering their exits.

Both sexes emerge from the pupae only during sunshine. The females do not embark on their first flight until the males have sought them out and mated with them. This the males do in large numbers, several males courting a single female at the same time.

Hornet mimics Britain's two largest clearwings–the hornet moth (*Sesia apiformis*) and the lunar hornet moth (*Sphecia bembeciformis*)–both measure 3 to 4cm ($1\frac{1}{4}$ to $1\frac{3}{4}$in) across the wings. As their common names imply, both species resemble the hornet in appearance.

Above: The hornet moth (*Sesia apiformis*) is a perfect example of insect mimicry since it closely resembles the hornet–a stinging insect predators do not touch–in both size and appearance. Its blackish-brown abdomen banded with yellow and its reddish-orange legs are remarkably wasp-like.

Above right: The larval and pupal stages of clearwing moths take place in burrows (which they excavate themselves) in tree trunks and branches. When the adult moths finally emerge they leave the empty pupal cases protruding from the exit holes, as in this picture of the hornet moth's pupal case.

Right: The red-belted clearwing (*Conopia myopaeformis*) can be a minor pest of apple orchards since its caterpillars feed on the bark of fruit trees. The adults are normally seen on foliage, looking remarkably similar to some species of ichneumon wasps.

The hornet moth is readily distinguished from the lunar hornet moth by its yellow instead of black head, and its yellow shoulder patches, which the lunar moth lacks although it does have a distinctive yellow collar behind its black head.

The hornet moth is on the wing in May and flies until the end of July and sometimes into August. The lunar moth, however, does not appear until late June and continues on the wing throughout July. Both species can be found on the foliage and trunks of their larval foodplant–hornet moths on poplars, and lunar hornet moths on willows and poplars–in the morning. The caterpillars are yellowish-white in colour.

Currant clearwing The little currant clearwing (*Synanthedon salmachus*) is perhaps the commonest British species and the only one which has become a serious pest in Britain–its caterpillars attack currant and gooseberry bushes. In appearance it resembles an ichneumon wasp–it has a black body with a black tail tuft and narrow yellow belts on the abdomen.

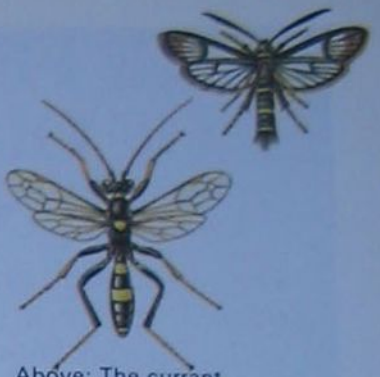
Currant clearwings fly in a single generation from June to August and may often be seen in gardens, sunning themselves on the foliage of their larval foodplants. If you split open the shoots of currant and gooseberry bushes, particularly those that are withered, you will probably see the small pinkish-yellow caterpillars wriggling in their tunnels through the stem pith.

Yellow-legged clearwing This handsome moth is locally common in the southern half of England. Its scientific name, *Synanthedon vespiformis*, refers to its mimicry of wasps (Vespoidea) since it bears an exceptionally close resemblance to some solitary wasps, such as *Gorytes mystaceus*, and to the workers of social wasps.

The yellow legs are the clearest distinguishing feature of this species; otherwise it has a black body with a pair of more or less united yellow spots where the thorax joins the abdomen, four yellow abdominal bands and an orange-red crossbar on the forewings. The female has one less abdominal band than the male, and her tail tuft is entirely yellow.

The adult moths are on the wing from the end of May until early August. You are most likely to find the whitish caterpillars between the bark and the wood of oak, sweet chestnut or elm trees.

Red-belted clearwing The caterpillars of this species can be a minor pest in apple orchards where the adults are seen on the wing from June to August. All black, with a single red belt around the abdomen, it closely resembles some species of ichneumon wasp–notably *Ichneumon suspiciosus*. The white caterpillars are tinged with red and feed under apple bark.



Above: The currant clearwing (right) mimics the ichneumon wasp *Amblyteles armatorius* (left).

Above: The yellow-legged clearwing (right) mimics solitary wasps such as *Gorytes mystaceus* (left).

Above: The red-belted clearwing (right) mimics the ichneumon wasp *Ichneumon suspiciosus* (left).

Above: The lunar hornet moth (right) mimics the hornet (*Vespa crabro*), shown left.

RARE FERNS OF OUR UPLANDS

The often bleak and barren appearance of our mountains belies the fact that some of our rarest and most delicate ferns are to be found there.

Above: Parsley fern growing in the crevice of a Welsh mountain. The fronds with the thin inrolled margins are fertile; the other fronds, looking rather like leaves of the parsley herb, are sterile.

Below: Both the alpine woodsia (here) and the oblong woodsia are confined mostly to higher latitudes, being especially common in Scandinavia and northern USSR, though they also occur in mountainous areas in the rest of Europe.

Ferns are generally considered to be plants of damp places, so it is surprising to find them growing in the seemingly arid environment of a mountain. Nevertheless, the conditions under rocks and on some ledges can be damp enough to allow spores to germinate and ferns to establish themselves.

Delicate filmy ferns The most delicate mountain ferns are the filmy ferns, an apt name because the blades of their fronds are but one cell thick. They grow only in places where the humidity is constantly very high and so are found on rocks by shady streams and waterfalls, and on moist, shady rock ledges. The thread-like rhizomes of these ferns branch to form a network over the surface of the substrate, producing the delicate fronds at intervals.

In filmy ferns, the sori (which contain the spore capsules) are not found on the underside of the frond blades, as they are on most ferns, but at the tips of some lobes of the blades. The sori are protected inside the cup-like indusium. This is a flask- or bell-shaped structure containing a thin spike–the receptacle–on which the spore capsules are formed. The spores of filmy ferns, like those of the royal fern and the horsetails, are unusual in that they contain chlorophyll and may begin to germinate before being shed from the capsule.

Rare Killarney fern Of the three species of filmy fern found in Britain, the rarest is the Killarney or bristle fern. This species is confined to just a few localities, having been made extinct in many areas through overcollecting. Fortunately, it is now protected by the Wildlife and Countryside Act of Parliament; it is now illegal intentionally to pick, uproot or destroy the plant, and to collect spores from it.

The name bristle fern comes from its conspicuous receptacles, which project from the sori. Its alternative common name, Killarney fern, reflects the fact that it was first noted in the British Isles in this region of Ireland.

The fronds of the Killarney fern are about 10-15cm (4-6in) long, though they may be much smaller, and have a dark vein running to the tip of each lobe. Its indusia are narrow and bell-shaped. It is now found in a very few areas in Britain, though it is more common in Ireland, especially the south-west. Although it is found in mountainous regions in the British Isles, it is not confined to this habitat.

Other filmy ferns Britain's two other species of filmy fern–Wilson's filmy fern and the Tunbridge filmy fern–differ most obviously from the Killarney fern in their receptacles. Unlike those of the Killarney fern, they do not protrude beyond the end of the indusia.

The two species are easy to distinguish from each other when fertile, for the Tunbridge has irregularly toothed indusial lobes, whereas the Wilson's has smooth-edged indusial lobes. This difference can be clearly seen with a x10 hand lens.

Above right: Wilson's filmy fern (*Hymenophyllum wilsoni*), a species that in this country reaches the northernmost point of its European distribution. In the British Isles it is confined mostly to Ireland and the western parts of Britain. It is very similar to the Tunbridge filmy fern, especially when sterile, though the Wilson's fern is a darker olive-green colour, whereas the Tunbridge is blue-green, and its fronds curve round at the tip and sides.

When the plants are not fertile they can still be distinguished, after a little practice. The Tunbridge filmy fern is blue-green with flat-spreading fronds; Wilson's filmy fern is a darker olive green with fronds that curve over the tips and margins.

Wilson's filmy fern, named in honour of a famous Victorian botanist, reaches the northernmost limit of its European distribution in the British Isles. It is found in Ireland and the west of Britain.

The Tunbridge filmy fern was long thought to be the same species as Wilson's. It was first recognised as a separate species from specimens growing near Tunbridge Wells in Kent – hence its name. Yet it grows in just a few places in south-east England, occurring mostly in south-west England, Wales, Scotland and Ireland, though even in those areas it is not common.

Protected woodsias Two other ferns of acidic uplands found in the British Isles are the alpine woodsia and the oblong woodsia. Both are extremely rare and, like the Killarney fern, are protected by law. They grow in damp rock crevices high up on mountains, the oblong woodsia in north Wales, northern England and Scotland and the alpine woodsia only in north Wales and Scotland.

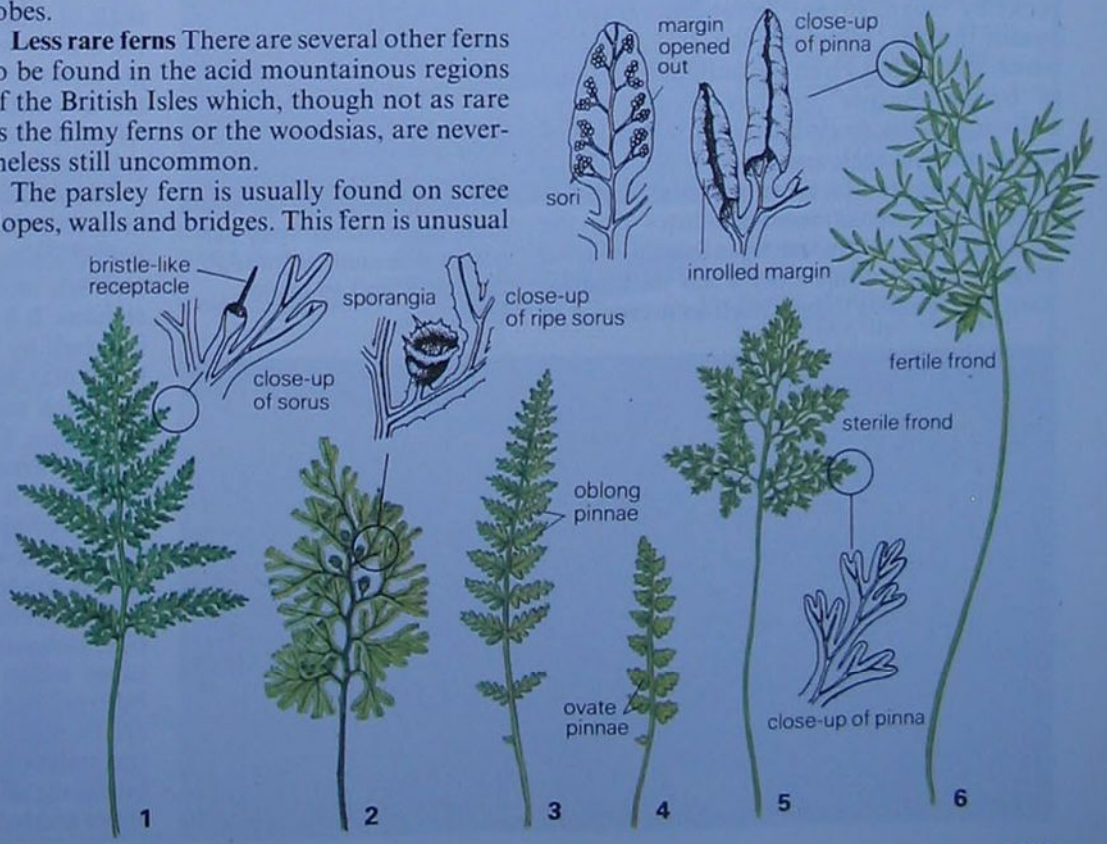
The two species are very similar, both growing from a short branching rhizome that produces only a few fronds at a time. These are usually 5-10cm (2-4in) tall and lance-shaped in the oblong woodsia, with oblong pinnae (the branching divisions of a frond) which usually have between seven and thirteen deep lobes. The alpine woodsia has oblong fronds 3-15cm (1-6in) long, with egg-shaped or triangular pinnae bearing three to seven shallow lobes.

Less rare ferns There are several other ferns to be found in the acid mountainous regions of the British Isles which, though not as rare as the filmy ferns or the woodsias, are nevertheless still uncommon.

The parsley fern is usually found on scree slopes, walls and bridges. This fern is unusual

in that its fertile fronds are often twice as tall as the sterile ones, reaching 30cm (12in). The young sori lie hidden under the unrolled margins of the pinnae.

The alpine lady fern is very similar to the common lady fern except that it is a smaller plant with circular sori. It is found only on rocks and screes in the Scottish mountains. Another species, the alpine buckler fern, is found in rock crevices in mountain areas of Scotland, the north of England and Wales, but it is so difficult to distinguish from its close relative, the broad buckler fern, that no one is sure of its distribution. The dwarf male fern, another mountain species, resembles the common male fern, but is smaller.

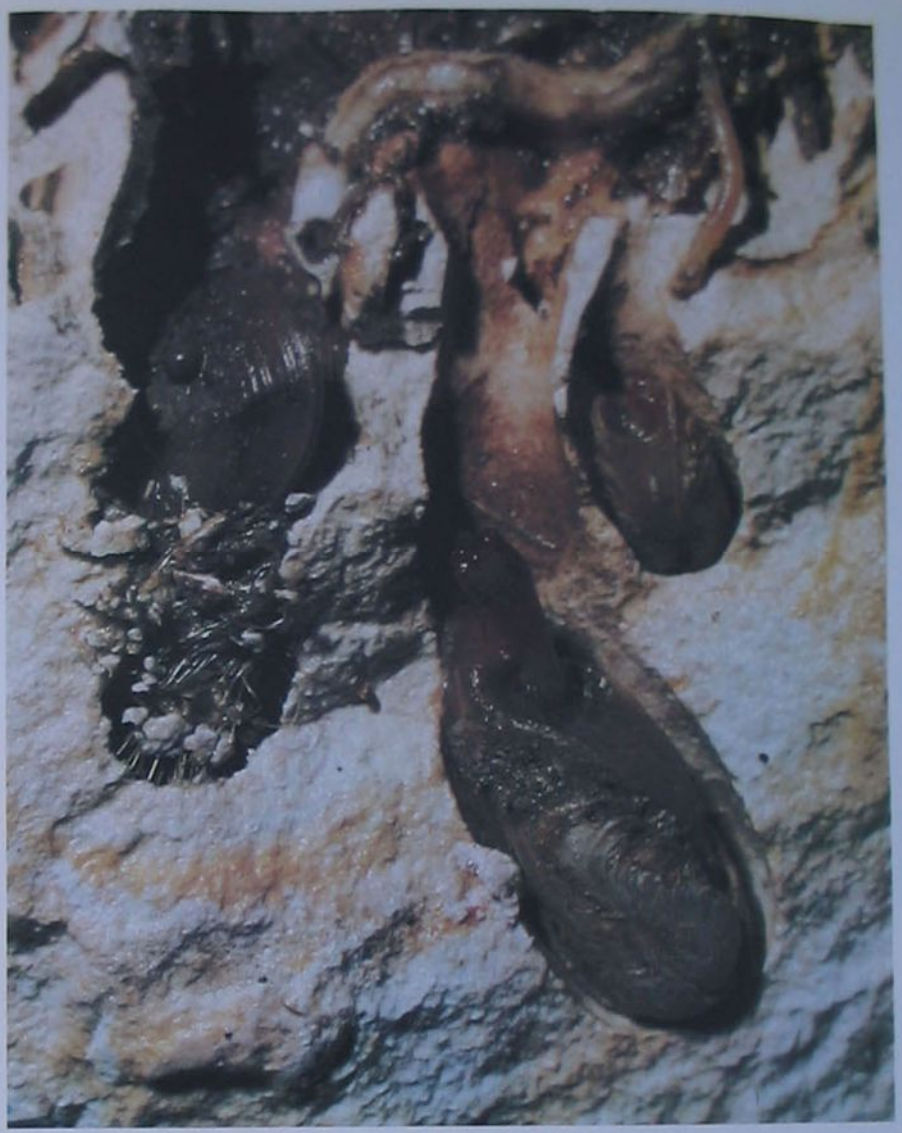


Mountain ferns

1 Killarney or bristle fern (*Trichomanes speciosum*) showing receptacle on sorus.
2 Tunbridge filmy fern (*Hymenophyllum tunbrigense*) with sorus.
3 Oblong woodsia (*Woodsia ilvensis*).
4 Alpine woodsia (*Woodsia alpina*).
5 Parsley fern (*Cryptogramma crispa*) showing sterile frond and pinna.
6 Parsley fern showing fertile frond with pinna and sori.

ROCK DRILLING SHELLFISH

Boring bivalves, as science unkindly names these extraordinary shellfish, use their hard shells to cut their way into rocks and wood.



Above: A rock cut open to reveal three *Hiatella* bivalves in their burrows. These are named red-noses after the pink or red tips of the siphons.

Below: Shipworms have eaten into this piece of driftwood and reduced it to a mere honeycomb. They can detect one another through the wood and so avoid collisions.

A bivalve is a mollusc – a member of the same group as slugs and snails. But, unlike a snail, a bivalve has two shells known as valves. These are generally saucer-shaped and fit closely together, housing the mollusc in the cavity within. Also unlike the snail, which uses its shell simply as a secure home, some bivalves have an additional use for their shell, for they function as excavating tools as well.

It is thought that bivalves evolved as burrowing creatures, working themselves into the sand by pushing with a single foot or manipulating their shells in a slow, shuffling movement. Having established itself securely, the bivalve passes its life filtering its planktonic food from the surrounding water, drawing the water in and passing it out through tubes known as siphons.

In the course of time, bivalves have evolved other methods of obtaining a secure anchorage. The common mussel, an example of a non-burrowing bivalve, anchors itself to rocks by tough, stringy secretions known as byssus threads. Here we look at a group to which science has given the unflattering name of 'boring bivalves', for they have the extraordinary ability to drill cavities in hard substrates such as rock and wood.

Beginning its life as an egg and then becoming a larva as most molluscs do, the typical boring bivalve emerges from the larval stage as a tiny 'adult' only a few millimetres long. The animal lodges itself in a crevice in its natural habitat – wood, limestone, clay, shale or other rocks. It gains a purchase inside the crevice with its extensible foot, then, as it grows larger, its shell develops hard ridges or teeth, which it uses to grind out the cavity. Often the bivalve and the cavity continue to grow over a period of years.

The red-nose The commonest rock-boring bivalve on the shores of the British Isles (and below shore level) is the red-nose (*Hiatella arctica*), recognisable by the pink tips of its siphons. It lives primarily as a nestler, attaching itself by byssus threads in rock crannies, but it may also bore a flask-shaped hollow in soft rock such as limestone or occasionally sandstone. The red-nose is a good example of a slow worker, for it bores less than one cubic centimetre a year, reaching a size, when fully grown, of $3\frac{1}{2}$cm ($1\frac{3}{8}$in).

The flask-shell A similar flask-shaped burrow is made by another bivalve, the flask-shell (*Rocellaria dubia*, formerly in the genus *Gastrochaena*). This species makes chalky tubes which protrude from the top of the burrow; they contain the siphons. The tubes are formed from a secretion that flows from the siphons. The flask-shell bores into sand, limestone and sandstone at the bottom of the shore and below, and is found in the south and

south-west of the British Isles. You can see it on the limestone blocks of the Plymouth breakwater in Devon.

The piddocks These are a highly successful group among rock-boring bivalves of the British Isles. Their shells are extremely hard, and have rows of fine teeth along the leading edge, facing into the burrow. Unlike the flask-shell, the piddock is only partly enclosed within its shell, relying on the burrow to provide protection.

The common piddock (*Pholas dactylus*), which occurs on the south coast of England, has a shell of up to 15cm (6in) long, the siphons extending as far again along the burrow. Other species include the oval piddock, the paper piddock, the white piddock and the little piddock, which has a shell only 4cm ($1\frac{1}{2}$in) long. The American piddock (*Petricola pholadiformis*) is not a true piddock but a relative of the Venus shells. It was introduced into south-east England in the last century and is now common in the Thames estuary.

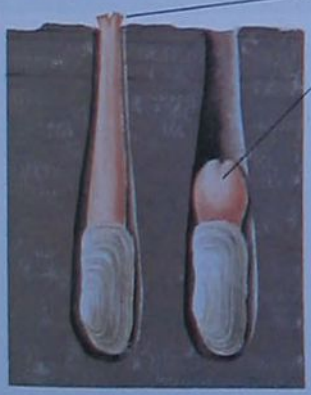
Piddocks are unable to detect each other's presence in rock, and consequently cannot avoid drilling into one another. If this happens, one piddock drills slowly but surely straight through the other.

The shipworms These notorious attackers of wooden vessels were a serious nuisance in the past, when ships were made of wood, and continue to be a pest today, if to a lesser extent. They do not look like bivalves, for they are long and worm-like, with only a small shell at the burrowing end, which is, however, a superb cutting tool and particularly suitable for working in wood. These animals can infest the timber of a boat's hull or a breakwater in such numbers that it becomes full of holes and collapses.

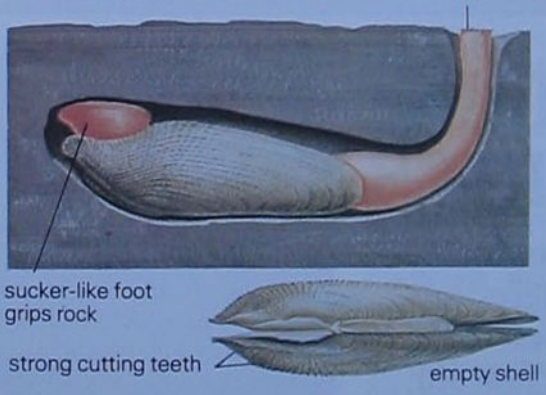
Shipworms are able to feed on the wood shavings produced when boring, in addition to their normal food–plankton. A special appendix helps to digest the wood. Shipworms are relatively short-lived, surviving about a year, and many of them change sex from male to female. Fertilisation may take place in the sea or, in some species, inside the female's mantle cavity.

Above: These common piddocks have drilled right through the rock (in this case a piece of fossil wood) and emerged through the underside. Normally this side is in contact with the sand, and the fossil has been turned over temporarily for photographing. You can see the fine rows of teeth along the leading edge of the shell, which acts as a file for boring deeper and deeper into the burrow. In some cases you can also see the muscular foot of the animal inside the shell.

Red-nose
Hiatella arctica

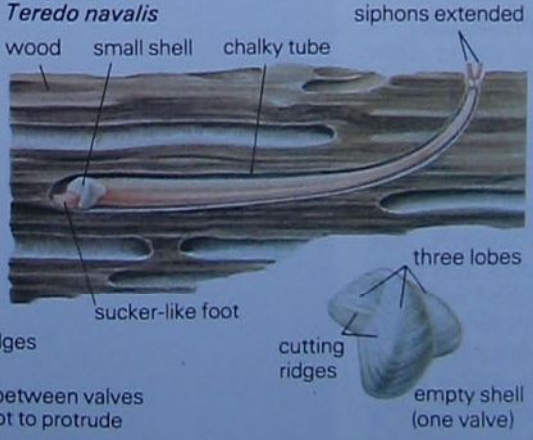


Common piddock
Pholas dactylus



Flask-shell
Rocellaria dubia

Shipworm
Teredo navalis



How the shells cut

The chief mechanical methods of cutting are:

Grinding outwards Water is taken inside the mollusc and comes under pressure when muscles retracting the siphons contract. The pressure forces the shell valves to grind against the burrow walls. This is the main method used by the **red-nose**, and **flask-shells** use it too.

Twist-drilling The sucker-like foot of **flask-shells, piddocks** and **shipworms** helps them grip rock and twist in the burrow like a drill.

Using leverage Powerful adductor muscles of **piddocks** and **shipworms** pull the valves open and shut, exerting pressure across a fulcrum half-way along the shell, so that the valves rock in a see-saw action. This causes rows of hard, sharp teeth outside the shell to cut into the rock or wood.

WILDLIFE IN QUARRIES

Quarrying has undoubtedly destroyed some interesting natural history sites–but in compensation a few old quarries have today become secondary oases of wildlife.

The limestone, clunch, sandstone, gritstone and granite quarried in Britain and used directly for building represents only a small fraction of that which has been worked in modern times. Limestone, particularly, has been used for many other purposes. It is both the largest single source of crushed rock for road aggregate, and an essential raw material for a wide range of industries whose products include steel, toothpaste and aerosols. It is the basis for building lime and cement, and is used directly as a top dressing for agricultural land that is too acid.

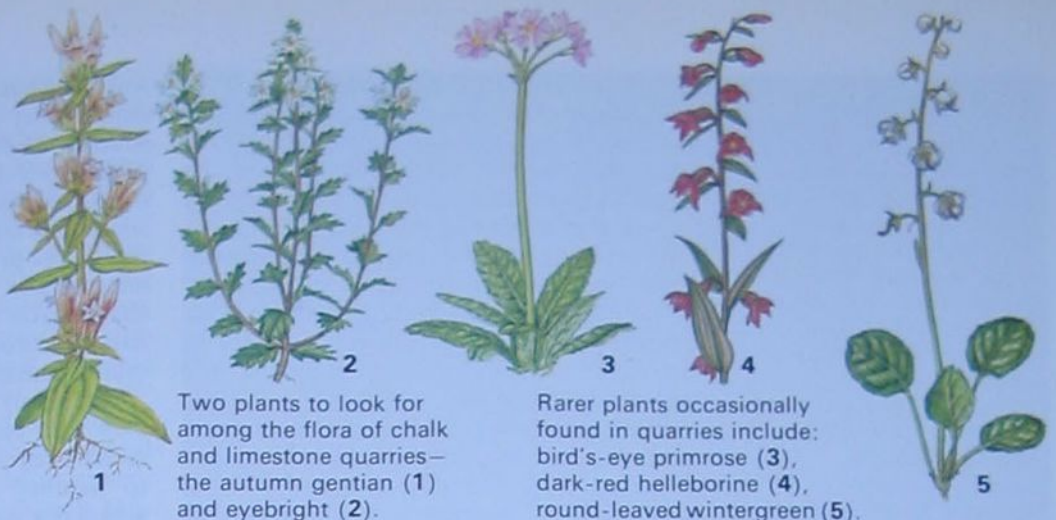
Chalk is only a soft form of limestone laid down in Cretaceous times. Its distribution in England has been likened to a £ sign, with a diagonal belt running across the country from Humberside and Norfolk to Dorset, and cross pieces forming the Wiltshire/Hampshire and North and South Downs. Other bands of limestone, all of them pitted with quarries, outcrop successively from east to west backwards through geological time–from the Jurassic of the Cotswolds and Lincolnshire to the Ordovician of Hereford and Worcester.

Sandstones are concentrated in Wales, south-west and north-west England and the southern uplands of Scotland, but they also encircle the Weald of Kent. Igneous rocks–such as granite–are more scattered and localised but form an important resource in the south-west, the Midlands and parts of Scotland.

Changes in quarrying The output of the quarrying industry has grown enormously during this century, especially since 1955 or so, but this has resulted from concentration of investment and effort, for there has in fact been a progressive decrease in the number of active quarries. In 1895, when regular statistics were first published, there were about

Above: An old chalk pit, well-colonized with shrubs and low-growing herbs. The many different flowers growing on chalk soils in quarries like this attract a wide variety of butterflies. Horseshoe vetch, for instance, is the foodplant of the caterpillars of the chalk-hill blue butterfly and the rarer Adonis blue (above right). Mineral exploitation in Britain goes back to antiquity, with the flint diggings in the Breckland of East Anglia and the extraction of metal ores in the Bronze Age. The quarrying of rock for roads and buildings also goes back to Roman times at least.

Right: A disused old slate quarry in Cumbria–decades may pass before a sparse covering of vegetation can establish itself in such desolate surroundings.



Two plants to look for among the flora of chalk and limestone quarries—the autumn gentian (**1**) and eyebright (**2**).

Rarer plants occasionally found in quarries include: bird's-eye primrose (**3**), dark-red helleborine (**4**), round-leaved wintergreen (**5**).

1500 chalk and limestone quarries working in England, but by 1955 the number had dropped to about half, and by 1973 to a little over a third. These figures, extended to other minerals, illustrate two important points: first, that some thousands of stone quarries have gone out of use in the last hundred years alone; and secondly, that many modern quarries are much larger than those worked 40 or more years ago. There are some exceptions, of course; several of those worked before 1940 for the steel industry in Co Durham and for cement in Kent, for example, are quite large by any standards. However, even these will look puny beside the mammoth quarries envisaged in the Mendips by the 1990s, which could be 3.2-4km (2-2½ miles) long and over 120m (400ft) deep.

Threats to nature If modern quarrying is seen as a discordant and intrusive element in the countryside today, it is partly because of its sheer scale and partly because it more often comes into conflict with other interests. These are mostly concerned with amenities and landscapes, but sites of high nature conservation value are also strongly defended. In Co Durham recently a public enquiry was held to discuss an application to quarry magnesian limestone underlying Thrislington Plantation—the most important area of limestone grassland in the county. Elsewhere, important woodland sites have disappeared or are being steadily eroded by quarrying—for limestone in the Mendips (Asham Wood) and Glamorgan (Garth Wood), or for granite in Charnwood Forest (Buddon Wood)—while others, such as Darenth Wood in Kent, have been threatened. The fall-out of limestone dust can also upset the delicate soil chemistry in limestone heath communities.

Nature's comeback Wildlife is clearly at risk in most active quarrying areas but, to balance this, it is actually re-invading abandoned quarries. New rock faces may be seized upon almost at once by cliff-nesting birds, and quarries are locally important in the lowlands of Britain for their populations of kestrels, stock doves and jackdaws. One old quarry near Tadcaster is actually called Jackdaw Crag for its colonies of these birds. This

Water wildlife

Upton Fields nature reserve in Warwickshire is derived from open-cast limestone workings in the 1950s. It is unusual in having many large parallel spoil ridges separated by narrow pools which support a rich aquatic life, including newts and dragonflies. There are also five breeding species of warbler. Access is to members of the Warwickshire Nature Conservation Trust who manage the area on behalf of the County Council.

quarry is believed to have been worked in the 10th century for stone for York Minster, so the jackdaws may have been there for a very long time. In the north and west of the country, quarries have also been used by ravens, peregrines and choughs.

Where quarrying has produced tunnels and caves, especially in the Isle of Purbeck, the Mendips and around Bath, these have often become strongholds for several species of bats, including the rare mouse-eared and greater horseshoe bats.

Plant colonization For plants, the story is quite different. Whereas an uncultivated field or garden quickly becomes a rampant riot of weeds if left untended, the natural re-vegetation of a quarry is usually very slow. Decades may pass before even a sparse covering of vegetation is established.

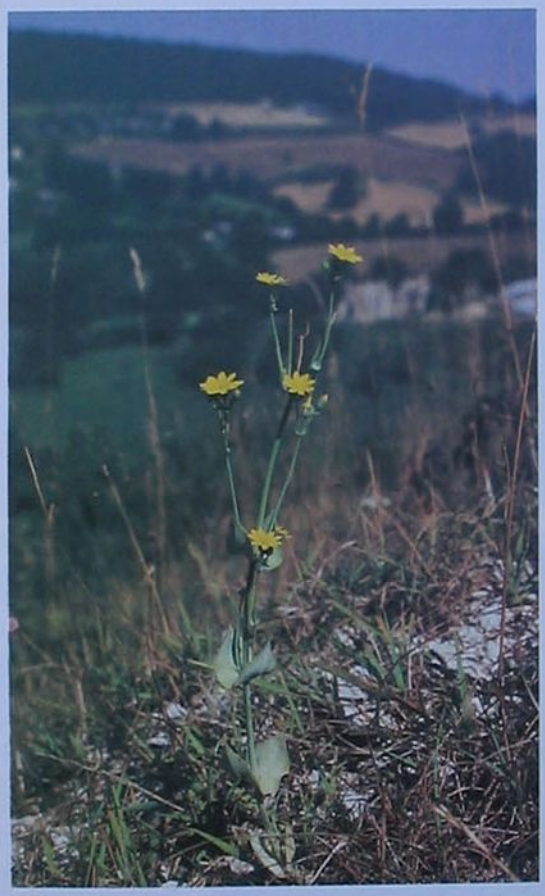
To start with, there is no seed bank once the soil itself has been removed, so colonization depends on dispersal of seed from outside sources. Then the stoniness, or compaction of the ground and the paucity of fine material on the surface, the extremes of heat and cold, acute shortages of water and nutrients essential for growth, and the absence of a soil micro-fauna and micro-flora to keep the energy cycle turning, all combine to create a harsh environment for germination and the establishment of seedlings.

For many years, indeed, growth remains slow and survival precarious. Hard, acidic rocks such as granite are particularly slow to weather and they produce material on which few plants can gain a foothold. On the other hand, chalk and limestone rocks break down more rapidly and produce a skeletal soil which can support a surprisingly large range of species. Thus, imperceptibly, the vegetation starts to close in until, after 40 years or more, quite a number of chalk and limestone quarries become attractive wildernesses of wild flowers–there are the yellows and oranges of bird's-foot trefoil, St John's worts, hawkbits and the carline thistle, the blues and purples of thyme, field scabious, greater knapweed, milkwort and felwort, the reds and pinks of centaury, marjoram and herb-robert, and the whites of oxeye daisy, wild strawberry and eyebright.

Several orchids, too, favour such conditions and you may find quarries dotted with bee, fly, butterfly and frog orchids and, in some places, dense colonies of spotted, marsh and fragrant orchids. Occasionally you can even find comparative rarities–blue-eyed grass, bird's-eye primrose, dark red helleborine, round-leaved wintergreen, Chiltern gentian or the tiny moonwort fern.

Two factors tend to encourage and maintain this transitional stage, which would otherwise develop into scrub and then woodland–the continuing shortage of nutrients, and rabbit grazing. Grasses and shrub and tree seedlings, particularly, are suppressed and so are unable to dominate and crowd out the more delicate plants. It is likely that the rate of change in vegetation has been more rapid since rabbit populations were reduced by myxomatosis in the 1950s.

Insect life Many quarries have a hummocky topography of old spoil heaps, offering shelter and shade that is much favoured by different insect species. The artificial cliffs and spurs also help to create sheltered, warm conditions appreciated by butterflies and other insects. Thus you may find the dingy skipper and common blue butterflies where their foodplant–bird's-foot trefoil–grows, and likewise the grizzled skipper with wild strawberry, the chalk-hill blue and the Adonis blue with horseshoe vetch, and brown argus with rockrose. These add a delightful element of colour and vitality to any site, while less conspicuous, if no less interesting, members of the fauna mostly go unnoticed.



Right: Yellow-wort on limestone–a plant to look for on disused quarry land. The dingy skipper butterfly (below) also frequents quarry sites.
Quarry workings can be a controversial topic. The conservation bodies that object to the opening of new quarries often enthuse about the secondary by-products of quarried land–the creation of species-rich habitats in old chalk and limestone pits, for example. Reclamation by in-filling is objected to on occasion–but even if the reclaimed sites do not match up to the original communities, they are sometimes the best available. These feral conditions may not be repeated in quarries worked out in the future–the quarries may be too big and too precipitous; some may be put to other uses; and some may not be near enough to other habitats for colonization to occur.

Nature reserves Partly because of their intrinsic appeal when quarries reach this condition, and partly because so much of our old, species-rich grassland has been lost through intensified agriculture, many quarries have been adopted as nature reserves by county naturalists' trusts in recent years. Examples include Hurley, Seale, Muckleford and Claxby chalk pits in Berkshire, Surrey, Dorset and Lincolnshire respectively, Trimdon Grange quarry in Co Durham, Stenders in Gloucestershire, Millers Dale in Derbyshire and Salt Lake in North Yorkshire. A few, like Stenders quarry, combine natural history and geological interest. Most quarry nature reserves are quite small, though Millers Dale quarry covers 24 hectares (60 acres).

What of the future? Minerals, like any other natural resource, can only be exploited where they occur, but unique wildlife communities derived from centuries of past land use are also irreplaceable.

It may be possible to preserve some habitats, such as grassland, by wholesale removal of turf and careful resiting in the quarry after the underlying stone has been taken away. Just such a bold experiment is in progress at Thrislington – as part of the planning permission for extension of quarrying there. It may also be possible to create new species-rich communities by suitable sowing of grasses, wild flowers, shrubs and trees, either directly in a disused part of the quarry or after infilling and landscaping. In both cases insight and vision are needed. In the meantime, researchers can learn much from the natural recolonization of quarries – some old quarries, indeed, could be regarded as outdoor working museums.

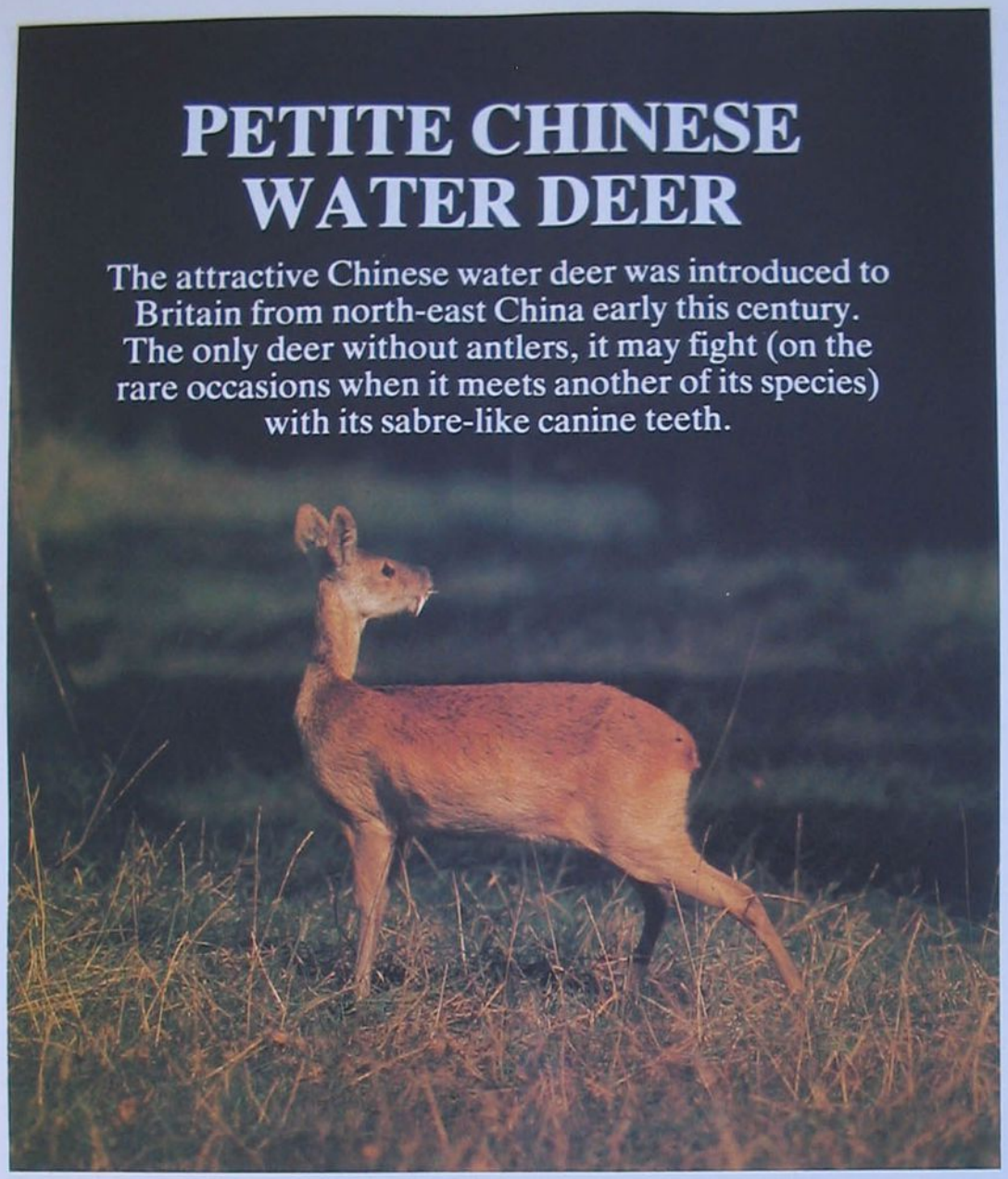
Where nature conservation cannot be justified, the amenity and educational values are sometimes worth exploiting. Generations of botany students from Cambridge have been to see the rare plants at Cherry Hinton pit, which is now a Caravan Club site. In 1972 a nature trail and guide were prepared as a result of co-operation between the Club and the Cambridge and Isle of Ely Naturalists' Trust. A nature trail has also been laid out at the recently established Amberley Chalk Pits Museum in West Sussex, where you can also review the whole fascinating life of a large 19th century limeworks.

Above: Hard, acidic rocks such as granite are slow to break down and produce material on which plants can take hold, but chalk and limestone, being altogether softer, break down fairly quickly, enabling such plants as this herb-robert to flourish.

Below: Bowers Quarry near Portland Bill, Dorset – a carpet of wild flowers covers the floor of this deserted old quarry.

PETITE CHINESE WATER DEER

The attractive Chinese water deer was introduced to Britain from north-east China early this century. The only deer without antlers, it may fight (on the rare occasions when it meets another of its species) with its sabre-like canine teeth.



CHINESE WATER DEER
(*Hydropotes inermis*)
Size of adult Male about 60cm (24in); weighs 13.6kg (30lb). Female 55cm (22in); weighs 11.7kg (26lb).
Breeding season Rut takes place in November and December. Fawns, born late May and early June are browny-fawn with rows of white spots along each side of body which fade as the fawn grows.
Gestation period 180-210 days.
No of young Litter size unusually large for deer, up to five or six in China, but fewer usually born in the British Isles.
Lifespan 15 years.
Food Grasses, small plants.
Predators Man, cats, dogs, foxes, stoats.
Distribution Bedfordshire, Cambridgeshire, Chilterns, Hertfordshire, Oxfordshire.

Left: A Chinese water deer buck, showing the tusk-like canine teeth which are his fighting weapons. The female also has tusks, but they are barely visible.

Below: In their native countries of eastern China and Korea, Chinese water deer inhabit reed beds and estuarine swamps. In England the deer visit pools and streams to drink but they rarely, if ever, swim.

The Chinese water deer, one of the smallest species of deer in the world, is only slightly larger than a fox. Like the muntjac, it was introduced to England by the Duke of Bedford early this century when he was collecting various species for Woburn Park. Some species did not survive over the years in a foreign environment, but the Chinese water deer thrived and multiplied in all but the severest weather. Although it is shy, nervous and independent of man, this deer has gradually become established in the countryside in Bedfordshire, Cambridgeshire, Hertfordshire, the Chilterns and Oxfordshire. However, this species is nowhere near as numerous as the muntjac.

Appearance The buck and doe look similar until the buck develops his distinctive canine tusks at the age of one and a half years. When seen head-on, the Chinese water deer is particularly attractive: it looks rather like a teddy bear with pricked ears high on the head, its nose and eyes appearing as three black buttons in its face. The adult has a plain coat which is reasonably uniform in thickness all over, but paler in colour on the belly and on the insides of the legs. The coat of both male and female is a reddish-sandy colour in summer, and a brownish-sandy colour, flecked with grey, in winter. The legs are short and slender and well proportioned to the body, and the feet are small with cloven hoofs and dew claws. From the rear the deer appears to have no tail: in fact the tail is about 9cm (3½in) long and thick, and in colour blends well with the rump.

Social life Most deer species congregate in herds for at least part of the year, but the Chinese water deer is mainly solitary. During late November and December the buck establishes his rutting territory by scent marking with faeces and urine, fraying plant stems with his teeth, and driving out any other competing bucks. He makes a deep bird-like chattering sound when herding the does.

Again unlike the other deer species, the Chinese water deer produces two or three fawns together. (Up to five or six are common

Left: A Chinese water deer in the snow, well protected by its thick coat. This coat, very thick for such a small animal, enables it to withstand extremes of temperature. There is little change in colour and thickness in spring and autumn, compared with other deer species.

Below: A Chinese water deer fawn has a dark brown coat with creamy white spots which last for the first three to four months. For the first six months male and female fawns appear similar, until the male develops his canine tusks.

in China.) They are usually born in June and for the first few days they lie tightly curled up together in grassland. After about a week they are able to jump up and run off if disturbed. For the next three months the doe is accompanied by her fawns, and is occasionally seen with another doe or a yearling doe. After six months the buck and doe are sexually mature, but usually the buck is not yet strong enough to compete for territory with older males, and he rarely mates before the following season. The female becomes pregnant when she is six months old and she gives birth for the first time when she is one year old.

Behaviour The Chinese water deer is most often seen on grassland where it feeds, rests and breeds. Sometimes it browses for fruits and seeds on the fringes of woodland. Its eyesight appears poor and if the animal is disturbed it tends to flick its head round every few degrees as though it is trying to focus on the passing object. It often stands quite still in long grass, apart from this head movement. If it is alarmed, it often turns on itself so sharply that it falls over, only to scramble up and run off at high speed, with the curious action of throwing up its hind legs much higher than its back every two or three strides.

In Woburn Park and the surrounding areas Chinese water deer are regularly struck by road vehicles, especially during the dark. If a fawn is handled by a human and then left, the doe associates the smell on her fawn with the scent of a predator and leaves it to die. Anyone who finds a fawn in the countryside should therefore leave it well alone. More often than not the doe is close at hand, waiting for the opportunity to claim her fawn and take it to a safer area, such as the long grass on the edges of woodland where the species is most often found.

Deer in Britain

AROMATIC PLANTS: SCENT SIGNALS

One of the most appealing aspects of a flower is very often its scent. Yet plants produce their aromas not for our benefit but to act as signals between themselves and the insect world, attracting pollinators and sometimes warning others away.

Below: The scent of a plant often provides a useful means of identification. For example, the plant below could be scentless mayweed, scented mayweed or stinking chamomile—they all look much the same. But rub a few leaves between your fingers and the difference between the three plants soon becomes apparent. As their names suggest, the first plant is odourless, the second has a pleasant aroma and the third stinks. The plant here is stinking chamomile.

Many plants have their own distinctive smell, ranging in seemingly endless variety from the clear sharp smell of crushed mint leaves and the sweetness of roses and honeysuckle to the decidedly unpleasant stink of hogweed.

The smell of a particular plant is the result of a particular combination of chemical substances. The plants expend a great deal of energy in synthesising these chemicals and it is not surprising to find that they are often of great importance to the plants for reasons ranging from pollination to defence. Nor is it surprising that many strongly smelling plants are commercially important since the aromatic chemicals they contain are often put to some useful purpose, for example in cookery.

Aromatic families Although aromatic plants are found scattered throughout a great many plant families, there are a small number of families in which a large proportion of the species have aromatic parts—whether foliage, stems, flowers or roots. In Britain, our most aromatic plant families are the mint, carrot and daisy families.

In the mint family, for example, several species have their own slightly different, though still minty, aroma. The similarity in their smells is due to the fact that they all contain menthol, a well-known ingredient of cough and cold remedies. But each species also contains smaller amounts of other substances, creating the slight differences in their smells, with the result that not all mints are equally popular as a flavouring. The daisy family numbers aromatic plants such as scented mayweed, wormwood, chamomile and pineapple weed (which does indeed have a smell reminiscent of pineapples) among its members and the carrot family includes hemlock, parsley, chervil and wild carrot.

Essential oils The scented volatile chemicals produced by plants are oils known as essential oils. They are secreted by special cells in the leaves, petals or other parts. On some species the droplets accumulate close to the surface and release their scent almost continuously. On other species the droplets are sunk more deeply, only releasing their scent if the plant is bruised.

Above: Strongly scented plants have long been used in medicines, sometimes simply because their distinctive smell suggested some valuable property. The roots of elacampane contain a strong-smelling camphor-like substance which acts as an effective antiseptic.

Below: Not all plants produce aromas to attract insects. The appropriately named stinking hellebore produces an evil smell that warns grazing herbivores of its poisonous nature.

In many members of the mint family the oil droplets are borne near the leaf surface and, on sunny days, the oil from plants such as thyme and lavender evaporates slowly to hang in the air around the plants. The process of evaporation has a cooling effect which may help the plant to avoid excessive loss of water from its leaves.

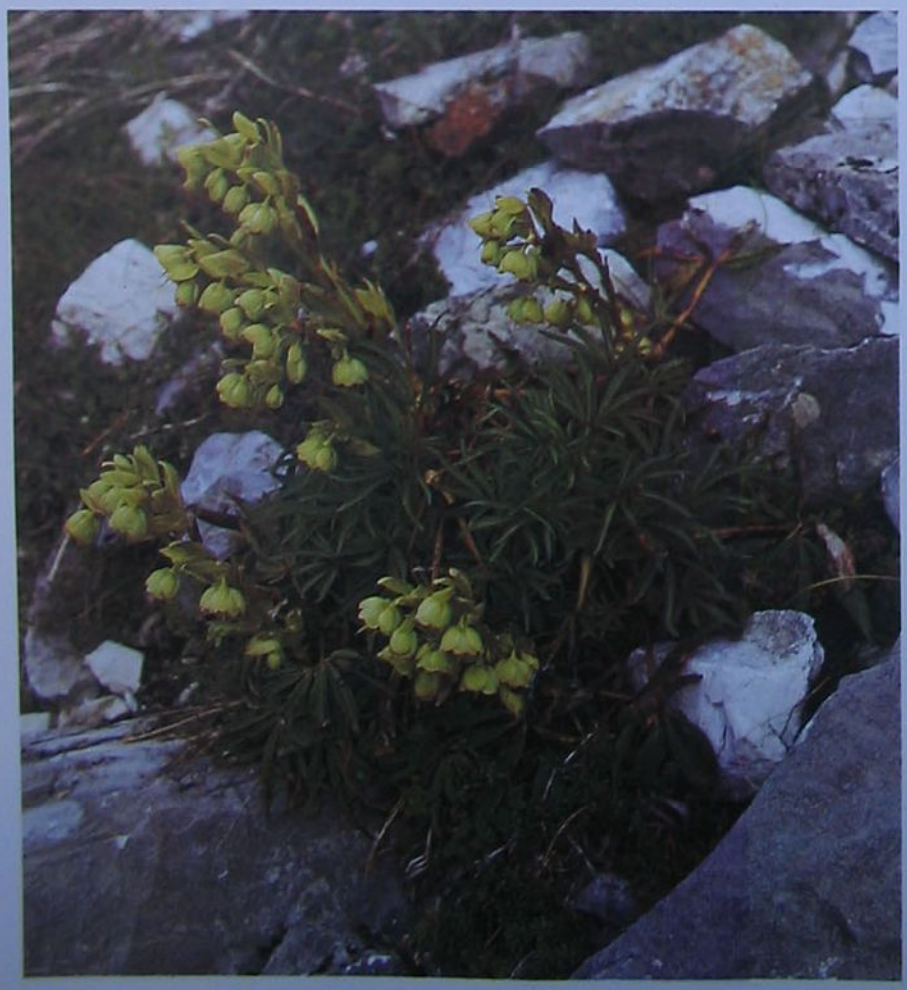
Other aromatic plants, such as ramsons, smell strongly only when their leaves are crushed – as anyone who has walked through a patch of these garlic-smelling plants will testify.

Chemical messages Although the aromatic oils released by plants do help to keep them cool, this is by no means their most important role. Their main role is to act as chemical messengers between the plant and those animals sharing its habitat. The messages are often very precise in their meaning, which may be to attract or repel, and they may be directed at particular species of animals.

Very few of these messages are intended for mammals, even though we are capable of detecting them by our sense of smell. Among the few exceptions are some unpleasant-smelling plants, such as stinking hellebore and hemlock, which are poisonous and warn grazing herbivores to avoid them.

In the majority of cases, however, the message of a scented flower is directed towards insects, most of which have an extremely acute sense of smell, telling them of the flower's location so that they may come and pollinate it. For smell is often just as important a factor in pollination as the colour of a flower, and in some situations it has distinct advantages. For example, it is effective over much greater distances than colour often is, and it works equally well in the dark as in the light, which means it can be used to attract nocturnal animals such as moths. On a similar principle, it is an important means of signalling for plants that grow in deep shade.

This system of chemical signalling between plant and pollinator works very well, for the sense of smell in such insects as butterflies, moths and beetles is so highly developed that they can detect the presence of a single flower, such as a honeysuckle, from more than 1 km ($\frac{5}{8}$ mile) away. They can even guide themselves to the source of the smell by detecting the increase in concentration as they approach the flower.



Selective smells The aroma produced by a plant depends very much on the type of pollinating insect it seeks to attract. Fly-pollinated flowers, such as hogweed and lords-and-ladies, attract flies by imitating the smells of dead and decaying flesh, on which fly larvae feed. The flies visit the flowers expecting to find a suitable place to lay their eggs and, even when they discover that the source of the smell is a flower, they may still be so convinced they have found a dead animal that they lay their eggs regardless. In doing so, they pollinate the flower.

Other plants aim to attract nectar-seeking insects by giving off a sweet scent that the insects associate with the promise of a meal of sugary nectar. These are the plants whose aroma we find attractive, such as scabious, violets, bluebells or wild roses.

The aromatic chemicals of plants play an interesting part in the lives of certain butterflies. The caterpillars feed upon a particular plant that the species finds naturally attractive, and in doing so accumulate traces of the plant's scent, storing them in their bodies. When they become adult butterflies, these traces are released as a means of attracting a mate.

Warning smells Not all plant odours are

attractive to insects. Some act as messages to potentially harmful insects, such as sap-feeding aphids, warning them to stay away or else risk being poisoned by the plant. These poisons act as natural insecticides and are often the scented chemicals themselves. Plants such as wormwood were traditionally hung in rooms to keep out flies, and sprigs of it were placed among stored clothes to repel moths. One plant-produced insecticide, pyrethrum (from the plant of the same name), is so effective that it is extracted commercially and used in a wide range of insecticides.

Air fresheners Although plants manufacture their scents primarily for the insect world, man has long used them to his own advantage. One such use, which was very popular in the past, was to employ aromatic plants as strewing herbs. These were gathered from the wild and then strewn over the floors of houses and public meeting places. Sweet flag, with its orange and cinnamon smell, lemon-scented balm, mints such as pennyroyal, and the sweetly scented flowering rush were all used for strewing.

Today, aromatic plants are still used as air fresheners. The clean fresh smell of pine resin, which contains turpentine and camphor, has been used in commercial air fresheners for more than a century. And, for a long time before that, pine cones were placed among stored clothes and blankets for their scent.

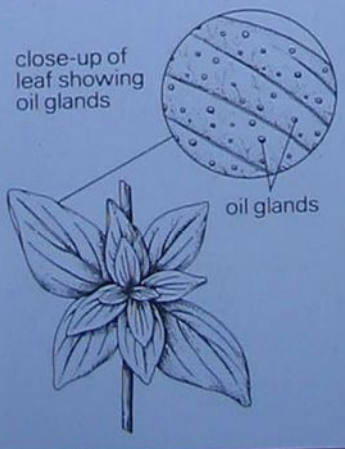
Herbs for the kitchen Nowadays, the most important use for aromatic plants, apart from their use in the huge perfume industry, is as culinary herbs. Adding parts of an aromatic plant to food began as a way of adding variety to an otherwise often monotonous diet, and of improving the flavour of plain, and perhaps also tainted, food. Herb gardens were widely planted and, over the centuries, many of the herbs cultivated in them have since spread into the wild and become naturalised, thus spreading far beyond their natural distributions. Fennel, balm, parsley and coriander are just four of the many plants thought to have been introduced to Britain by the Romans for their culinary qualities and have since become naturalised to some degree.

Above: Hoverflies attracted to the flower head of an umbellifer by its scent. Umbellifers, as plants in the carrot family are known, are often strongly scented and frequently have white flowers. It may be that plants relying on scent to attract pollinating insects have no need of coloured petals or other parts to act as a further attractant, and so tend to be white.

Right: Some plants are poisonous to insects, releasing odours to warn of their nature, and have been utilised as such by people for centuries. Pennyroyal used to be hung up to repel fleas, and was strewn around the floors of houses for the same purpose.

St John's wort

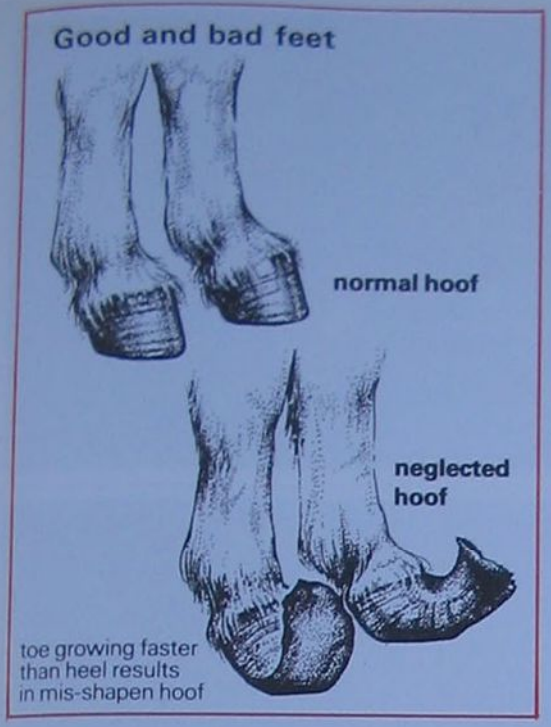
Several species of St John's wort have numerous oil glands in their leaves, which can easily be seen if you pick a leaf and hold it up to the light. Shown here is common St John's wort, also known as perforated St John's wort because of the appearance of its leaves. During the Middle Ages these perforations gave rise to the idea that St John's wort healed wounds, because its leaves appeared punctured yet remained alive. So, during the Crusades, the plant was used by the Knights of St John of Jerusalem to cure wounded crusaders – hence the name St John's wort.



DONKEYS AND MULES: FRIENDS AND PETS

Donkeys have always suffered from being thought stupid and stubborn – and words such as 'asinine' and such sayings as 'silly ass' perpetuate this false impression. They are, in fact, as intelligent as horses and ponies, only becoming stubborn when they do not understand the orders given to them.

Below: Donkeys have a distinctive 'cross' marking which consists of a dark eel-stripe running down the spine from the base of the mane to the tail, and across the shoulders. Traditionally the cross is regarded as a mark of honour commemorating Christ's entry into Jerusalem, mounted on a donkey, on Palm Sunday.



Above: A male donkey. In the past it would have been known as a 'jack', but now it is frequently referred to as a stallion. Females used to be known as 'Jennys' or 'Ginnys'; now they are called mares.

Left: The feet of a horse and a donkey. Those of the donkey are, quite literally, killing him: the animal is forced to walk on its heels because the toe has grown faster than the heel and has not been trimmed. This does not usually happen in the donkey's natural habitat where the rough ground keeps the hoof worn down.

Below: A donkey mare with her foal. Many people keep donkeys as working animals or simply as delightful pets.

Donkeys are not indigenous to the British Isles, but the exact date of their arrival here is unknown. There is no evidence of their presence before Anglo-Saxon times, but they were common by the Norman Conquest. In the following centuries, although they have never achieved the status of their equine cousins, the horses and ponies, they have played an important, if largely unrecognised, role in both rural and urban life in the British Isles. Today there are thousands in private ownership as working animals, especially in Eire, but more particularly as enchanting pets.

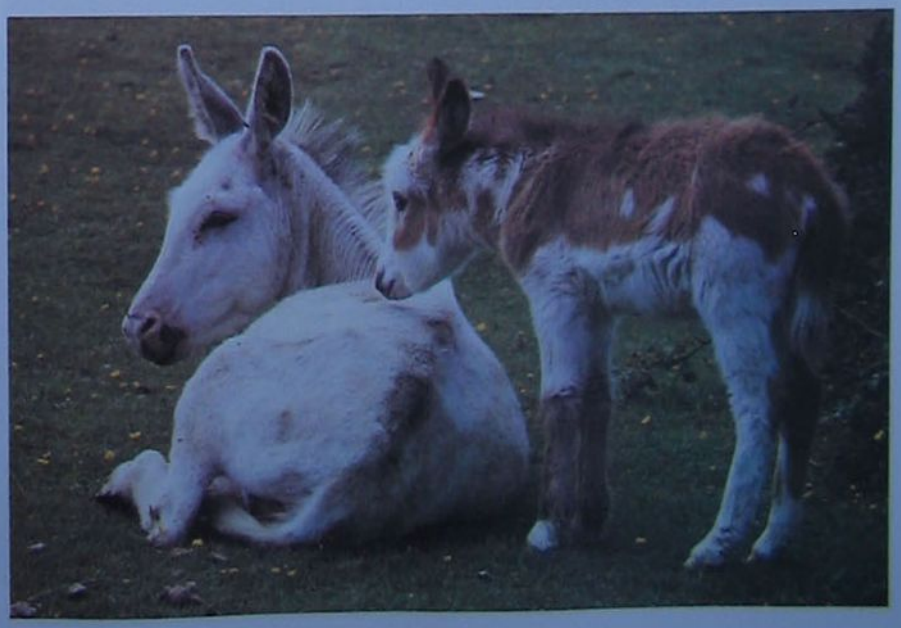
African origins The scientific name for the domestic donkey or ass found in the British Isles is *Equus asinis*, and the breed is descended from the wild ass of Africa, a native of Somalia, Nubia and parts of Sudan. The general appearance of the donkey–with its long ears and kindly expression–is too familiar to need a detailed description, but it does have a number of features which are of special interest, as they underline some of the variations that exist within the equine genus.

Both donkeys and British native ponies are equines, but although the former's origins are in the arid areas of Africa, the pony's distant ancestors were north European. This could well explain the difference in the coats of the two species: the pony, which has been domiciled for a long period in a cold, wet climate, has developed a coat that is almost totally waterproof. The winter coat of the donkey, on the other hand, does not have the double layer, typical of native ponies, nor do the hairs lie in such a way as to channel the water off the body. The result is that in prolonged rain the donkey becomes wet right through to the skin, and it consequently lacks hardiness in this respect. In addition, it does not have the 'tail chute', or tuft of hair at the root of the tail (found in the ponies) that prevents rain running down between the hind legs.

Equines from hotter, drier climates tend to have smaller, more 'boxlike' feet than those from more temperate climates, possibly because smaller feet are more suitable for the ground over which they move in their native habitat; the more 'spread' feet of the ponies were adapted for the lusher, even marshy ground of northern Europe.

The wall of the donkey's foot is usually more upright than that of the average pony, and its hoof-prints show clearly that the feet themselves are a different shape. Although they have the same basic structure as those of the horse, the constituent parts differ in proportion and importance. The donkey's fore foot is relatively longer and narrower than the hind foot of a horse or pony, and its hind foot is more elongated again. The donkey, in contrast to the pony, is almost flat-footed since the sole of its foot is not arched. The frog, which in the pony is large and acts as a shock-absorber, is small and almost vestigial in the ass.

The texture of the donkey's feet, too, is different from that of the horse. It is elastic, not brittle, and in domestic donkeys which



are neglected, this leads to appalling problems. When a horse's feet are not trimmed regularly, the horn of the hoof grows, but only to a limited extent. The brittle nature of the horn ensures that it will break off, and thus not grow over-long.

In the donkey, however, the hoofs continue to grow, the toe faster than the heel, and the whole structure becomes deformed into a kind of 'winkle-picker' shape. If this condition is further neglected, the toe turns upwards in a curve (like the traditional slipper of an Eastern potentate) and the unfortunate animal is forced to walk on its heels. This does not normally happen in its natural habitat where the ground is rough enough to keep the hoof worn to the correct length.

Another vestigial feature is the 'chestnut', the small leathery growth on the inside of the forelegs of donkeys (and on all four legs of horses), which is regarded as the remains of one of the original four toes of the equine ancestor. The 'ergot', another vestigial structure, appears on the rear of horses' fetlocks, but is almost completely lacking in donkeys.

The distinctive cross running down the spine and across the donkey's shoulders is a link with the ancestral wild equines from which both donkeys and zebras are descended, and in the case of the donkey, is virtually all that remains of the stripes.

Many colours There is a considerable range

Right: Donkeys resting in a friendly group. The herd instincts of donkeys are not developed to anything like the same extent as other equines, such as zebras and horses. In the wild they tend to live in very small groups, although one often goes off on its own. Such behaviour might easily be disruptive among horses, but donkeys seem to take no notice at all.

Hybrid mules

Mules are hybrid animals, produced by mating a male donkey with a female horse or pony. The cross of a female donkey and a male pony is known as a Hinny or Jennet. Although the genetic make-up of mules and hinnies is the same, ie half-horse, half-donkey, hinnies tend to be smaller because in the breeding of equines the size comes from the dam and the conformation from the sire.

Although both male and female mules are anatomically capable of breeding, and the female comes into season and even, occasionally, into milk, the breed is sterile. There is no doubt that male mules are sterile, and it has long been believed that females, too, are sterile, but for centuries there have been occasional reports of a female mule with a foal. This has almost always proved to be a donkey foal. Recently, however, it has been suggested, in theory at least, that a female mule could become pregnant to a horse. This could occur, some scientists say, in very unusual and complicated circumstances. (A similar process has been demonstrated in some mice and also in some species of tree frogs.

Mules vary in size from 12-17 hands and over, and they have large ears and a horse-like tail; their colours are more varied and horse-like than the donkey's. In spite of their unenviable reputation for stubbornness, mules, like donkeys, are amenable animals when treated correctly, and are stronger, weight for weight, than horses. They are also much more economical to feed than either horses or donkeys.

The present number of mules in the British Isles is unknown. Today they are used almost entirely for driving, although in other countries they are used for riding and as pack animals. Scrap dealers occasionally use them for pulling their carts. In the past they were widely used in market gardens because their narrow feet enabled them to walk between row-crops more easily than the broader-hooved horse.

Above: Mules can vary in size from 12 to 17 hands and over. They have large ears and a horse-like tail. Unlike most donkeys, the mule's belly is the same colour as the rest of its body.

Below: Mules are hybrid animals, produced by mating a male donkey with a female horse or pony; this mule is a donkey-Welsh pony mix.

Mules have been in Britain probably since Roman times–evidence of their presence is seen in place names such as Moulsoe, Moulscombe and Mulgrave, all of which date from Saxon days and mean mule farm. As long ago as the 18th century mules were bred in the New Forest (for export to America) by crossing donkeys with New Forest ponies. The recently formed Mule Society suspects that there are probably many more mules than is generally thought, some of which may not have been recognised as such.

of colours in domestic donkeys, although brown and grey are the most common. The muzzles and bellies are usually lighter. Other colours include white (actually very pale grey), black, roan, and (rarely) chestnut. There are also broken-coloured animals including piebald (black and white), skewbald (brown and white) and Appaloosa (white with small black spots). These unusual colours are of comparatively recent origin, and are not found in the wild. They probably result (as in some other domestic animals) from crosses between different strains that could not possibly, for geographical reasons, occur in the wild.

Donkey habits In terms of feeding, donkeys are hardier animals than horses and ponies. They can eat and thrive on much rougher grazing, and in this country are often seen eating brambles and thistles.

Donkeys usually live in small groups in the wild. This lack of herd instinct is useful today: a donkey kept on its own as a pet is quite content with human company, while a lone horse almost invariably seeks other horse company, even to the extent of jumping out of a field. If a number of horses are kept in a field and one decides to gallop around, the rest of the herd will follow suit. This is unlikely to occur with donkeys. One may go off on its own, and the rest will probably ignore it.

A donkey is often turned out in a field with a highly strung and excitable race-horse. Although it may gallop about a little, it will soon return to graze quietly with its donkey companion. Indeed, the calming influence of donkeys is such that they are sometimes the constant companions of race-horses, even travelling with them to the racecourse.

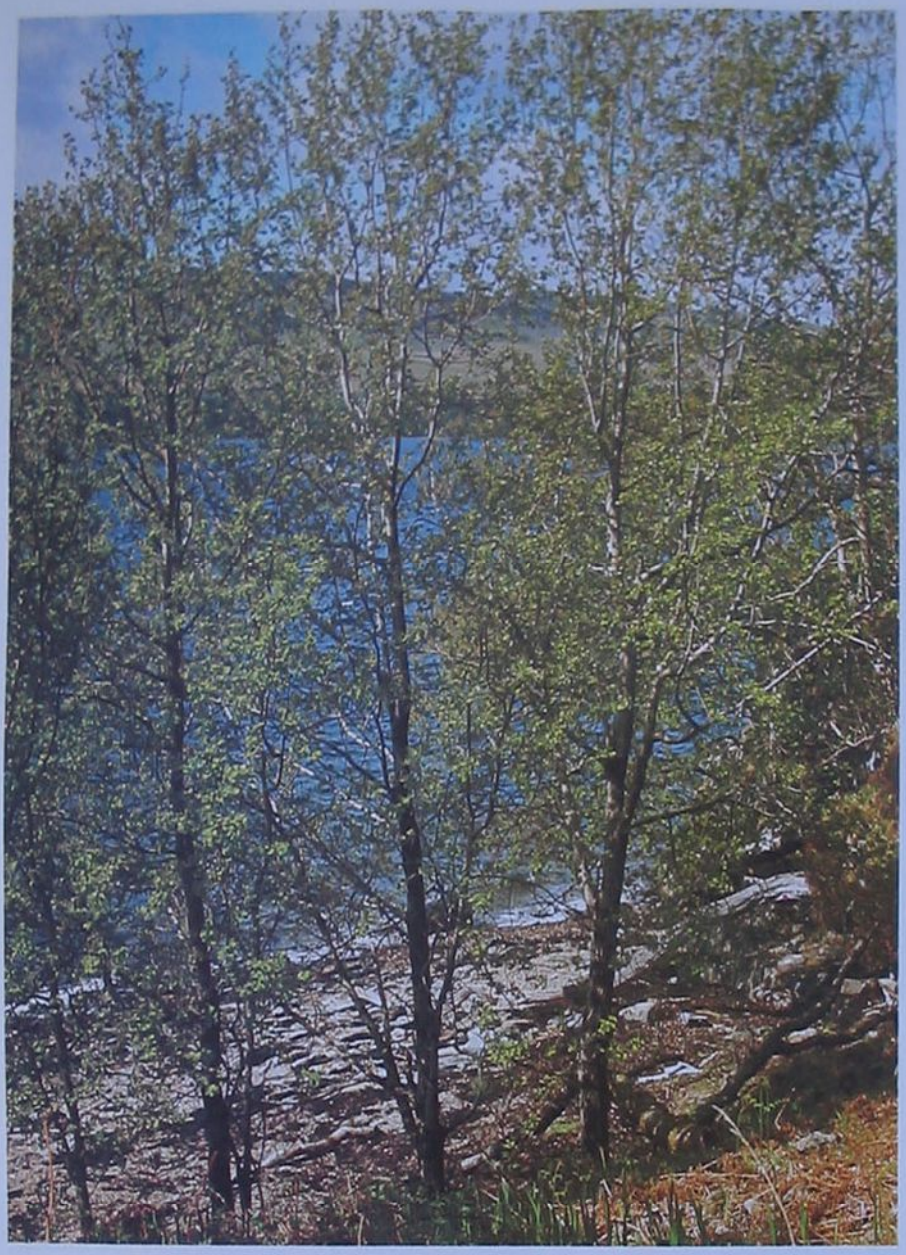
Working animals Today donkeys are primarily pets in the British Isles, but in the past they were very much working animals. In Ireland they still take farmers and their milk churns to market. During the last century in Britain they were used for surface work at a number of coal mines, carting the coal to nearby canals for transport to other places, and they were also used for local coal deliveries. Before the widespread establishment of mining towns many miners used to ride donkeys across country to work. However, they were mainly used by small traders for deliveries.

Donkeys also played a small part in agriculture, and it was as a 'spin-off' from this that beach donkeys were first used. Farmers used their animals to cart sand to lighten heavy soils, seaweed as fertiliser, and seashells for alkaline dressing. After the short working season the animals were hired to take holiday-makers for beach rides.

Today donkeys are used for children's riding, for driving–they have played a part in Driving for the Disabled–or simply as a delightful family pet. Since the establishment of the Donkey Breed Society in 1967, breeding for show has become an important aspect of the donkey cult, and the Society has set its own standards. Partly as a result of this slightly more up-market approach, the older names by which donkeys were known appear to be falling into disuse. Male entire donkeys, once known as Jacks, now are frequently referred to as stallions; and females, once known as Jennys or Ginnys, now are mares.

Above: A skewbald donkey foal on open forest. Donkeys tend to live longer than horses–40 years is not unusual.

Below: Donkeys carrying peat in Ireland, where they are still working animals.



THE TREMBLING ASPEN TREE

One of our less familiar native trees, the aspen is sometimes called the quaking aspen because its leaves tremble in the slightest breeze–a feature that has been the source of much folklore, all associating this pretty tree with evil and gossip.

Above: A stand of aspens by a lake. They are most often seen on hillsides and valleys, especially where the soil is fairly damp and light. They can be found in other habitats, however, and tolerate a wide range of soil types.

Although the aspen is not one of our well known native trees, it occurs throughout the British Isles, being more common in the north and west of the country than in the south. Valleys and hillsides are typical habitats for this tree, though it sometimes grows in hedgerows and copses, and it is quite often seen in open oakwoods.

Outside Britain the aspen is found as far north as Iceland, Norway and northern USSR, south to Sicily, Greece and North Africa, and east to Japan.

Trembling poplar The aspen is a species of poplar, its Latin name of *Populus tremula* reflecting the fact that its leaves quiver in the slightest breeze. Like other poplars, the aspen is a fast-growing tree, reaching a maximum height of about 20m (65ft). When young it has an open conical crown, which becomes broader with age.

The bole often leans to one side and suckers are freely produced around the base, so that single trees may eventually form dense thickets. The bark is grey-green and smooth, with darker oval depressions.

The shape and size of the leaves vary according to whether they come from the main part of the tree or from the suckers. Normal leaves have a blade about 3-7cm (1-3in) long and at least as broad as that, with shallow rounded teeth. The stalk is 4-6cm (1½-2½in) long and strongly flattened in such a way that the slightest breeze causes the leaf to flutter vigorously. Leaves borne on suckering shoots may be much larger–up to 15cm (6in) long–and are egg-shaped with more prominent teeth. Their stalks are also much shorter.

Both types of leaf are the same colour: copper-brown when they first emerge in the spring, gradually becoming grey-green or green on the upper surface and paler underneath. The leaf-stalks are much paler, being yellowish or almost white in colour. In late October, the leaves turn pure yellow and provide an attractive display in some years. However, aspens in other countries seem to have much better autumn colours than ours.

Spring catkins The aspen flowers in March, before the leaves appear, bearing separate male and female catkins on separate trees–as do other poplar trees. The male catkins are usually borne in great numbers and are quite thick, 4-8cm (1½-3in) long and greyish-brown, although they can appear yellowish when releasing pollen.

The catkins produce no scent or nectar and so are not visited by potential pollinating insects. Instead, pollination is carried out by the wind. After pollination the male catkins turn brown and soon drop off.

The female catkins are slimmer than the males and greenish with grey hairs and reddish bracts. They grow to about 4-6cm (1½-2½in) long and bear purple stigmas. After pollination they may lengthen and can be as long as 12cm (5in) by the time the seeds are fully ripe, which is in June. At this stage the female catkins appear whitish and release white woolly seeds. The seeds can often be seen carpeting the ground around female trees.

Versatile timber The timber of aspen, and indeed of other poplars, is not of particularly good quality, but it has been put to a number of different uses. The most important of these are the construction of various types of boxes

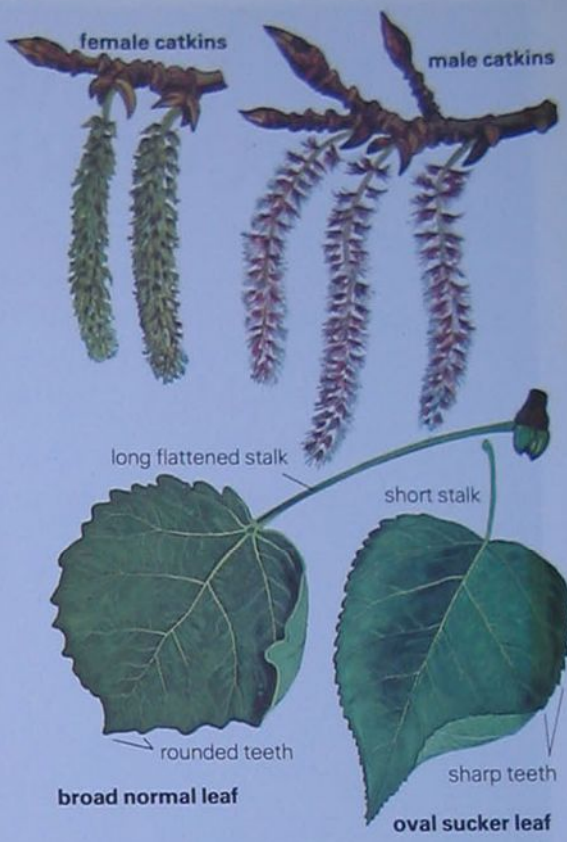
and the production of wood pulp. The wood is also used for making matches and, in the past, for arrows. Commercially, aspens and other poplars have the advantage over other trees of growing very rapidly in the right conditions.

Evil associations The aspen's almost constant leaf movement has been the source of much local folklore and legends throughout the range of the tree's distribution. Many have a biblical basis. In Wales it was said that the aspen was used to make the Cross and, for this reason, its leaves would never rest. In some areas of Scotland the aspen was regarded as evil because it was the only tree not to have bowed during Jesus' procession to the Crucifixion. As a result, people used to avoid using the wood. Indeed, feeling was so strong against the aspen in Scotland that some people used to throw stones at it.

There are similar legends elsewhere in Europe. In Germany, Jesus is said to have cursed the aspen because it would not acknowledge Him and, in parts of Russia, it was known as the tree of Judas.

The movement of the aspen's leaves seems to have led to associations with the sound of gossip and loose tongues, particularly (and rather chauvinistically) with the tongues of women. This association is found in parts of Scotland, where the tree is known as 'old wives' tongues'. In parts of Berkshire it was referred to as 'woman's tongue' and the Welsh name for the aspen, 'coed tafod merched', also refers to the same image, as does the Manx name of 'chengey ny mraane'.

Nowadays, it seems strange that such an attractive and pleasing tree should, in the past, have been the subject of so many evil associations and unpleasant stories. Without these, the aspen might perhaps have been more widely planted than it has been.



Above: Normal aspen leaves are short and broad with shallow rounded teeth, whereas sucker leaves are usually much larger and oval with sharper teeth. The difference can be seen clearly in a direct comparison (above right).

Aspen (*Populus tremula*). Native deciduous tree growing up to 20m (65ft) tall. More common in the north and west of Britain.

Below: Fruiting catkins dispersing their seeds.

THE MIRACLE OF METAMORPHOSIS

Insect metamorphosis is one of the most astonishing phenomenons in the animal kingdom. Although some insects hardly change at all during their lives, others undergo the most remarkable transformations – from worm-like larvae to dainty winged adults.

The term metamorphosis refers to the changes in form undergone by an animal during its period of growth from youth to maturity. These changes may be relatively slight – as in human beings – or the young may pass through stages totally different in appearance from the adult. Such profound metamorphosis is conspicuous in crustaceans such as crabs – and in the insects.

Both these groups belong to the great animal phylum Arthropoda – animals which periodically moult in the course of their growth. At each moult (ecdysis) there is an increase in size and a greater or lesser change in the animal's structure and appearance. Among land animals it is certainly the insects which have the most dramatic metamorphosis.

Three types of metamorphosis As might be expected, the primitive wingless insects display the least degree of metamorphosis. In the silverfish (*Lepisma saccharina*) – a common inhabitant of kitchen cupboards – the young are replicas of the adults on a smaller scale. A silverfish may live for several years and shed its skin as many as 50 times, but it never changes dramatically in appearance.

In the more highly evolved winged insects, however, the nature of their metamorphosis is of such importance that it forms the basis of their classification. This divides them into two groups with the rather cumbersome names Exopterygota and Endopterygota. Exopterygote insects, which include dragonflies, grasshoppers, bugs and various other orders, have an 'incomplete' life-cycle – egg, nymph and adult (imago); endopterygote insects (butterflies, moths, flies, bees and wasps) have a 'complete' life-cycle – egg, larva (caterpillar), pupa (chrysalis) and adult (imago).

These two distinctions – Exopterygota and Endopterygota – are based on the way in which the insect's wings grow during metamorphosis. In the former they grow outwardly and are externally visible in the early stages – as with grasshoppers – while in the Endopterygota they develop inwardly and only appear on the outside in the pupal stage – as in butterflies.

Incomplete metamorphosis In the Exopterygota the early stages are referred to as the nymphal stages. Development proceeds in steps which correspond to the ecdyses or moults. No stage, however, is profoundly different from the one which precedes it.

In grasshoppers, the wings become visible after the second ecdysis, when they appear as flattened buds on each side of the thorax. After this the buds increase in size with each moult, growing outwards until they reach their full development after the last ecdysis. The grasshopper's long hind legs also increase gradually in size and are used for hopping well before the last moult.

The bugs (Hemiptera), which form the other large order of exopterygote insects, have a pattern of growth similar to that of the Orthoptera (grasshoppers, crickets and loc-

usts). In both these orders there is no considerable change in the way of life or feeding habits when the insects become adults. Most of them pass their entire lives on land, or in the water as with water bugs.

Water nymphs There are some orders of exopterygote insects which do alter their lifestyles dramatically between the nymphal and adult stages. These are the aquatic nymphs that leave the water when they acquire the power of flight. Naturally this complete change of life involves an alteration in appearance.

In the case of a dragonfly or damselfly the nymph, which has hitherto spent its life underwater, crawls up a reed out of the water, its skin splits and the mature insect crawls out. Its wings, which have been developing gradually with the growth of the nymph, are fully formed but folded and crumpled. Their expansion is most spectacular, but other structurally important changes also take place.

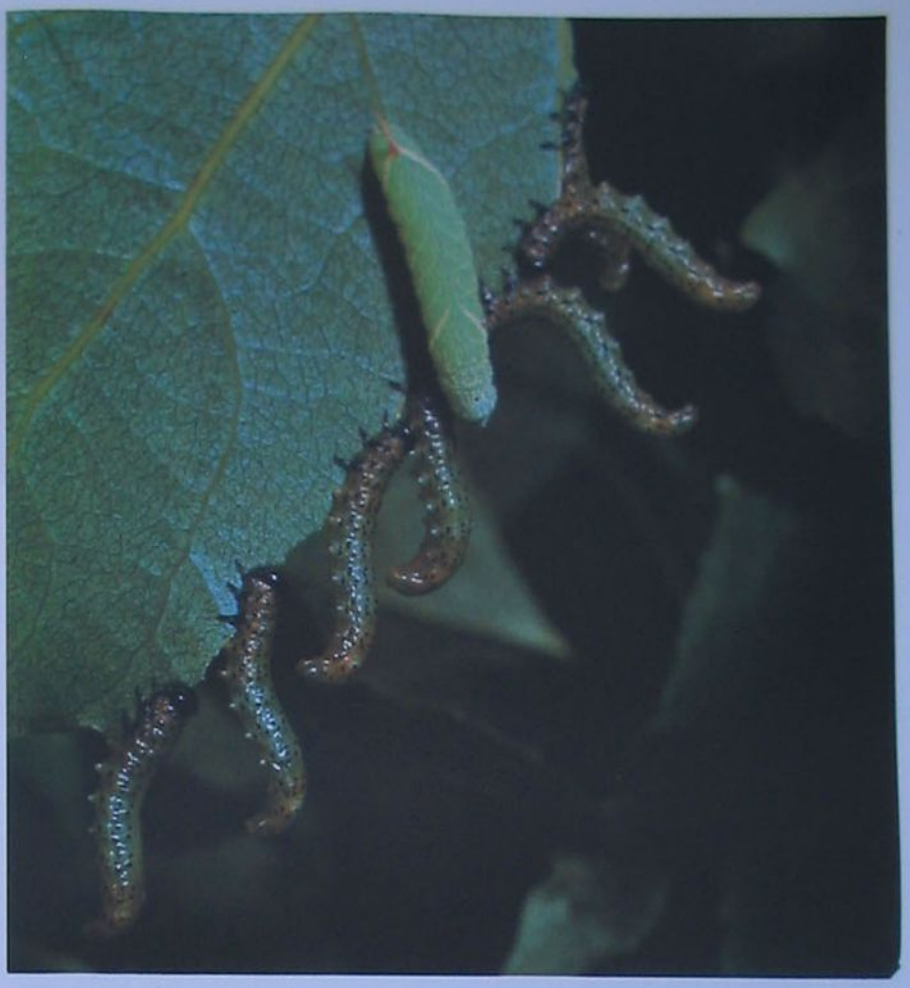
The adult's legs occupy a forward position and are used to hold the prey, so they functionally replace the hinged lower lip (labium) of the nymph which was used to catch the prey. Astonishingly, the labium remains functional up until a few days before the nymph emerges from the water. The eyes also grow dramatically during this period.

Fishermen's duns Another group of insects with aquatic nymphs are the mayflies–they also change abruptly from aquatic nymphs to completely aerial adults. Mayflies are unique among insects in undergoing one more ecdysis after the wings are developed. The nymphs crawl out of the water or float to the surface, and the insects which then emerge (known as duns by trout fishermen) are dull coloured with expanded wings, though their powers of flight are rather feeble. After a short time the duns settle and shed a very thin layer of skin from their bodies, legs and wings, which immediately become bright, shiny and fully coloured.

Mayflies do not feed as adults and only live long enough to mate and lay their eggs–in some species this may be just a day or two. They have become proverbial examples of a brief life, although in fact they are among the longest lived of insects, since the nymphs may take two to three years to grow and come to maturity.

Reincarnated as a butterfly The metamorphosis of the insects so far described is exopterygote or incomplete. The complete or endopterygote metamorphosis occurs in only the most highly evolved insects and is a remarkable process. The feeding and growing stage of an endopterygote insect is known as larval. In the case of a butterfly this is a worm-like animal with short legs which spends its time eating, growing and periodically shedding its skin, and then turns into a pupa (chrysalis), after which it is reincarnated as a butterfly.

The most profound changes take place



Above: Sawfly larvae and a poplar hawk-moth caterpillar.

Opposite page: An adult dragonfly soon after emerging from its nymphal case, which is also visible in the picture.

Right: A puss moth caterpillar spinning a cocoon in which to pupate.

Below: During the nymphal stage grasshoppers look remarkably similar to the adults, with their well developed legs and antennae.

Above: The most profound change in the life-cycle of the clouded yellow butterfly takes place between the larval and adult stages. When the caterpillar hangs itself up to pupate, all the organs and muscles not required by the adult are destroyed and liquefied by wandering blood cells. The resultant 'organic soup' provides the material and energy for building the adult's organs. On emerging the butterfly is completely unrecognisable from its original larval form.

when the larva or caterpillar hangs itself up to pupate or finishes spinning its silken cocoon. At this stage a process called 'histolysis' commences in which almost all its muscles and most of its internal organs are destroyed, digested and liquefied by wandering blood cells known as 'phagocytes'. The end product –an organic soup– provides the material and energy for building up the organs and appendages of the adult butterfly. Clumps of cells which have resisted the process of dissolution and remained alive form the basis for the butterfly's organs. In this way the substance of the larva is reconstituted to form a butterfly.

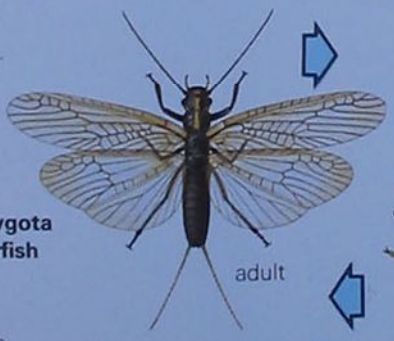
Its wings, arising from the inwardly growing buds, turn outwards and the new legs, antennae, eyes and mouthparts, already formed at pupation, can be seen in outline on the shell of the pupa. When the butterfly emerges and expands its wings it is as different in lifestyle from the caterpillar whose life it inherited as a bird is different from a snake.

Other important endopterygote orders of insects are bees, wasps, ants, flies and beetles. All of these have a definite pupal stage between the larva and the adult (imago).

Obtect and exarate pupae There are two distinct types of pupae, called obtect and exarate. The obtect is less common, but more familiar as it is the kind found in almost all butterflies and moths. In this type the cover-

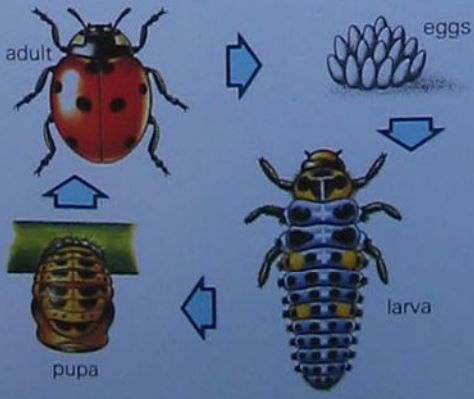
Understanding metamorphosis

Apterygota –silverfish



Exopterygota–stonefly

Endopterygota–ladybird



Wingless insects such as silverfish are apterygotes, and hardly change at all during metamorphosis–the young looking very much like smaller versions of the adults. The stonefly belongs to the exopterygotes (which also includes dragonflies, bugs and grasshoppers), since its life-cycle comprises three distinct phases–the egg, nymph and adult stages. The other type of metamorphosis–that of Endopterygota–is illustrated by the ladybird which, like butterflies and moths, has four particular stages–the egg, larva, (caterpillar), pupa (chrysalis) and adult.

Pupa round-up

Exarate pupa–wasp

There are two types of pupa. Exarate pupae (bees and ants) resemble bedraggled and lifeless adults since their appendages are encased in pupal sheaths, but are free from the bodies. The appendages of obtect pupae (moths and butterflies), however, are embedded in the bodies. While moth pupae are usually dark and bullet-like–they often live underground and so need no camouflage–butterfly pupae are various shapes and colours to escape detection by birds.

Obtect pupa –purple emperor butterfly

Obtect pupa– spurge hawkmoth

ing of the limbs, wings and antennae is cemented down, forming a continuous surface with the body, although the appendages can be seen quite clearly in outline. Some kinds of flies, and the ladybirds among beetles, also have obtect pupae.

The exarate pupa is more common and is found in bees, wasps, ants and most beetles. It looks similar to a lifeless and bedraggled version of the adult, with the wings represented by small bags, and the appendages encased in a pupal sheath but free from the body. A newly formed exarate pupa is often white, but it darkens in colour as it approaches hatching time. Some of the best examples of exarate pupae can be found in broken-up combs from bee and wasp nests or, on a smaller scale, in ant nests. The pupae are almost always inactive.

Why metamorphosis? The various forms of metamorphosis described above apply to different groups of insects: Apterygota applies to the wingless primitive insects, Exopterygota represents the winged insects which have evolved further and Endopterygota applies to the winged insects, such as butterflies, which are the most highly evolved.

It is evident that in the course of their evolution – from primitive to highly developed forms – insects have increased the complexity of their life histories. Such complex adaptations would never have come about if they did not represent some advantage to the species.

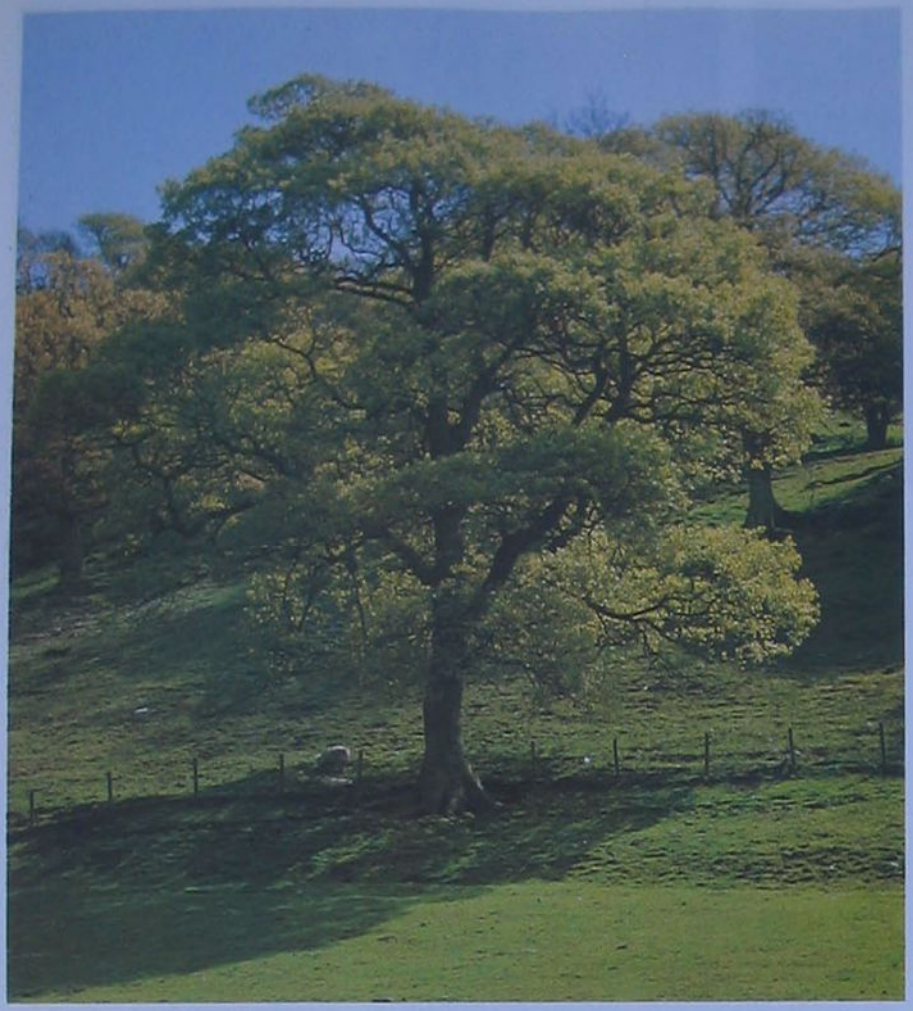
To understand this it is necessary to consider what an animal must do to ensure the continued existence of its species – it must escape its enemies, feed and grow, and finally reproduce successfully.

Adaptations for protection from enemies are evident in all stages of the insect's life, but it does most of its feeding, and all of its growing, during the larval stage – an endopterygote insect never grows larger once it has emerged as an adult. Some insects do not need to feed during their final winged stage, and those that take food only do so in order to provide themselves with energy.

On the other hand, larvae and nymphs do not engage in sexual activities. These are confined to the adult, which is as elaborately equipped for everything concerned with offspring as the larva is for feeding and growing.

Hence a larva or nymph is specialised for feeding and growing and an adult is specialised for reproduction, and specialisation can be one of the roads to success. This is probably one reason why natural selection has produced metamorphosis in the place of a simple life history.

Below: When the time arrives for its final moult the dragonfly nymph crawls up a reed or stick projecting from the water. Here the adult – which is now fully formed within the nymphal case – splits its outer skin and emerges. Its wings, which developed gradually as the nymph grew, are fully formed but folded and crumpled. Their expansion, which is seen so clearly in the picture, is the most spectacular feature of the dragonfly's emergence. Other important changes which take place at this stage are the growth of the eyes and an alteration in the mouthparts. The aquatic nymph caught its prey by shooting out its hinged lower lip (labium), while the adult catches its victims with its legs.



THE HOTEL OAK– HOST TO MANY

Vast numbers of animals and plants obtain food and shelter in oak trees, between them using every part from the roots to the catkins and acorns. Some of these 'guests'–usually the insects–have definite food preferences and are only found in oaks.

Above: Even a young oak tree plays host to a huge number of 'guests'. The natural distribution of our two native oak species has been much modified by man, and both now occur in a wide variety of habitats all over the country, although the sessile oak is fairly uncommon in East Anglia. Climatic factors, however, dictate that the sessile oaks of our northern woods support fewer insect species than the pedunculate oaks of lowland forest and coppice.

Our native oaks belong to two species–the pedunculate oak and the sessile oak. The pedunculate oak has stalked acorns and almost stalkless leaves, whereas the sessile oak has stalkless acorns and stalked leaves. The preferred habitats of the pedunculate cover the heavy, base-rich clays of lowland Britain, while the sessile is essentially an upland species at home on the acidic rocks of the north and west.

The trees display a great deal of variation, especially in leaf shape, due to variability within each species and also to frequent hybridisation. However, this variation has little effect on the vast numbers of plants and animals that obtain food and shelter from the oak. These 'guests', both permanent and temporary, live on both species of oak, whether they are growing in woodland or hedgerow or even in solitary splendour in a park.

Hangers-on The rough bark of the oak provides footholds for a wide variety of plants which cling to trunks and branches. These plants, known as epiphytes, derive their mineral requirements from bird droppings and other debris accumulating on the bark and do not take any food from the trees. They reach their greatest development in the damp climates of the north and west, where tufts of greyish-green lichens completely clothe the branches. The lichens include several species of *Usnea* (known as beard lichens from their wispy appearance), and numerous coarser kinds which stand on or hang from the branches like miniature bushes. They often have their own fauna of caterpillars and other lichen-feeding insects, including the incredibly well-camouflaged caterpillars of the Brussels lace moth, which look just like pieces of lichen themselves.

Many kinds of mosses live epiphytically on the oak bark, as do several ferns. The most abundant fern is the common polypody, whose branching rhizomes creep over the bark and throw up their evergreen fronds at intervals. The rhizomes are normally on the upper sides of the branches, or in debris-filled forks, and are often covered with moss.

Flowering plants are not commonly found as epiphytes, although wood sorrel may occasionally take root in humus-filled hollows, but several species can be found climbing oaks in hedgerows and woodland margins. They include traveller's-joy, honeysuckle and the ubiquitous ivy, which shelters a variety of animal life, especially nesting birds like the treecreeper and the spotted flycatcher.

Fungal partners Many kinds of toadstools grow under oaks, especially in moist woodlands. Most feed on the decaying leaf litter, but many form definite partnerships with the oak roots. These associations are called mycorrhizas. The fungal threads surround the smaller roots and often penetrate the outer cells, from which they obtain sugars and other food materials. In return, they help the roots to absorb water and minerals, although neither partner is entirely dependent on the other. Many of the fungi grow equally well on the roots of other trees. Among those commonly associated with oaks are the penny bun bolete and the crimson-capped *Russula xerampelina*. The death-cap is also common in oak woods and is believed to form mycorrhizae.

Older trees are attacked by a variety of parasitic fungi. One of the most serious of these is the honey fungus, which produces dense clusters of brown toadstools at the bases of the trees. It probably does not attack healthy trees, but can quickly invade and kill those weakened in some other way. It con-

tinues to grow on the dead trunks and stumps, in company with sulphur tuft, many other toadstools and bracket fungi.

Feathered guests The oak provides feeding opportunities for a wide range of birds, although few actually feed on the tree itself and none is restricted to oak. Most of the birds are attracted by the huge insect population found on the leaves and bark. Warblers search diligently among the foliage throughout the summer, collecting caterpillars, aphids and other tasty morsels, while blue tits and great tits search the bark as well as the leaves, even managing to find insect eggs and other food in the bark crevices in the depths of winter. Other bark-searching birds include the woodpeckers, treecreeper and nuthatch.

The jay is one of the few birds actually to use the oak as food, avidly stripping and eating the acorns in the autumn. Woodpigeons, too, eat large numbers of acorns; together with bullfinches they also eat many oak buds in spring.

The oaks also provide nesting sites for birds, especially the hole-nesting tits and woodpeckers. Starlings often take over old woodpecker holes. Tawny owls nest in the larger holes and use oaks as sheltered daytime roosts.

Casual mammals None of our native mammals is entirely dependent on the oak, although the introduced grey squirrel would certainly go hungry without it, for buds and acorns make up much of its diet. Wood-mice and badgers eat acorns, and so do deer. The deer also browse on the lower leaves and commonly strip the bark from young oaks. Rabbits graze seedlings and have a marked effect on regeneration in woodland.

Insect defoliators Thousands of insect species feed on oak – far more than are found on any other British tree – and between them they use every single part, from the finest rootlets up to the catkins and the topmost acorns. Over 100 kinds of moth caterpillars feed on the buds and leaves, some often so numerous that they defoliate whole branches and even small trees.

One of the commonest is the green oak tortrix. Hundreds of these caterpillars may drop on silken lifelines if the oak branches are shaken in May or early June. Left alone, they gradually climb back up their threads to their homes in folded or rolled leaves, where they pupate and emerge as adults in late June and July. The winter moth is another very common defoliator.

Sporadic defoliation by caterpillars does not appear to do permanent harm – and in fact the tree can fight back. The production of a second crop of leaves – the lammas leaves – is one important factor in maintaining vitality. It has been shown that defoliated twigs open fewer buds in the following spring, thus denying homes to many young larvae and so causing a subsequent fall in population.

Other caterpillars often seen on oak in-

Above: Pipistrelle bat with young – these and other mammals make good use of oak trees but are in no way restricted to them.

Right: A well-disguised buff-tip moth. This moth's caterpillars live communally on oak in their early stages.

Below: Bracket fungi of many kinds sprout from the trunks of aged oaks. They include the beefsteak fungus (shown here), whose brackets have the colour and texture of raw steak. Another species, *Ganoderma applanatum*, produces wrinkled, horny brackets near the base of the trunk and covers surrounding bark with a layer of spores that look like cocoa powder.

Above: Green woodpeckers both nest and feed in the shelter of oak trees.

clude those of the mottled umber, buff-tip and lackey moths. The latter are red, white and blue with black stripes, and spend their lives living communally in a silken tent spun over the leaves. Buff-tip caterpillars also live communally in their early stages, although they make no tents. They cluster tightly together on the leaves by day, their bold yellow and black colours warning birds that they are unpalatable. They feed mainly at night. The caterpillar of the merveille-du-jour moth also feeds at night, spending the day on the bark where it is beautifully camouflaged. The adult is also well-hidden on lichen-covered bark by day.

The purple hairstreak is our only butterfly feeding on oak in the larval stage. The adults, too, are rarely seen away from oaks, usually appearing in mature woodland where they like to fly around the topmost branches. The adults feed mostly on honeydew–exuded by the millions of aphids infesting the oak leaves. The purple emperor butterfly also glides around oaks, but its larvae feed on sallow.

Gall wasps and other animals Oak apples and spangle galls are among the scores of different oak galls caused by gall wasps. These tiny black or brown insects lay their eggs in the oak's tissues, which then swell up around the developing grubs to form the galls. Each species has its own characteristic gall. Most occur on the leaves and twigs, with others on the roots and catkins, and some even on acorns and tree trunks.

Shaking an oak branch over a sheet can bring down a veritable rain of insects. It is not possible to mention more than a few of them, but among the more conspicuous are the aphid-eating ladybirds and the brown and green lacewings, the scavenging earwigs, and various leaf-chewing weevils, including the green *Phyllobius argentatus*. Numerous leafhoppers and other bugs, such as the forest bug, abound on the leaves.

Spiders are also abundant on the leaves, notably the delicate green *Araneus cucurbitinus*, which spins a small orb web between adjacent leaves. *Diaea dorsata*, a bright green and brown crab spider, is difficult to spot when it is lying in wait for prey among the leaves. *Theridion pallens*, another spider, is often abundant, the pale globular female being most frequently found in curled-up leaves where she sits guarding her sputnik-like egg cocoons.

Trunk roads During the daytime the oak trunk does not display a great deal of activity, although careful searching will usually reveal several well-camouflaged moths. At night, however, the trunk becomes a busy highway as many small animals roam up and down in search of food or mates.

Woodlice are among the most abundant of these animals. With no waterproof covering, they spend the daytime safely tucked up in a bark crevice or in the debris at the base of the trunk, but they wake up as the humidity rises with nightfall. They browse on algae and lichens on the bark, and experiments have shown that they venture higher up as the humidity rises.

Other animals contributing to the trunk traffic include earwigs, bark lice, centipedes, millipedes, harvestmen, hunting spiders and various ground-beetles. None of these travellers is in any way restricted to the oak, but on the other hand there is probably no oak tree without them: they can be regarded as true residents. They may well hide during the day in the ivy that often grows on oak tree trunks. Although not a parasite–it takes nothing directly from the oak–ivy competes with the tree for light, air and minerals.

Below: From August until leaf-fall, most of the branches of an oak support the oak bush-cricket–a beautiful pale green insect that hides by day and roams the foliage at night in search of small insects to eat. It commonly flies to windows and street lamps at night.

The teeming oak

1 Great tit catching insect prey.
2 Nuthatch on trunk.
3 Purple hairstreak butterfly.
4 Grey squirrel on branch.
5 Starling in nest-hole.
6 Nut-boring weevil on leaf.
7 Merveille-du-jour moth on trunk.
8 Beard lichen (*Usnea*) on branch.
9 Cherry gall and cherry gall insect.
10 Spangle gall and insect.
11 Tortrix moth and dangling larva.
12 Woodlouse on trunk bark.
13 Centipede on trunk bark.
14 Wren among ivy on trunk.
15 Jay feeding on acorns.
16 Bracket fungus *Ganoderma applanatum*.
17 Stag beetle on ground under oak.
18 Wood sorrel near oak trunk.
19 Seedling oak.
20 Badger feeding on acorns.
21 Harvestman on oak trunk.
22 Penny bun bolete fungus.

RING OUZEL: A MOUNTAIN BLACKBIRD

A hardy relative of the blackbird, the ring ouzel is a summer visitor, breeding each year on mountains and moorlands in the British Isles.

The ring ouzel is very much the 'mountain blackbird', an upland species keeping to mountain, moor and fell. Although blackbirds are found just as far to the north and west as ring ouzels, in all areas the blackbirds are the birds of the valleys, with plentiful bush or tree cover, while ring ouzels are birds of high-altitude, open landscapes or exposed, almost treeless areas nearer to sea level in the far north.

Differences from blackbirds The black plumage of the ring ouzel has a sooty, non-reflective tone, unlike the velvet blackness of the blackbird. As well as the vivid white crescent on the upper breast–known as the gorget–there are also smaller, pale crescent markings on the body, and some brownish overtones. The beak is yellow, unlike the strong orange colouring of the male blackbird's beak. The closed wings appear grey rather than sooty black, and in flight the grey contrasts strongly with the body: this is a useful field identification feature.

The female is browner, and her gorget is often buff-coloured or an indistinct white. The young pose something of an identification problem if seen in the absence of adults. They are brown-backed and have grey-brown wings, but they also have a white throat (as in some female blackbirds) not a collar or gorget. The breast is cinnamon, with bold, thrush-like dark blobs. After moulting in autumn they resemble their parents.

Above: A female ring ouzel incubates her eggs. As in the blackbird, the female ring ouzel is a browner version of the male. Often the gorget is less pure white than in this case.

Left: Ring ouzels are unusual in having a higher rate of hatching success than most birds.

Below: Breeding distribution matches the pattern of mountains–except, mysteriously, in Ireland's mountainous south-west.

Spacious territories Ring ouzel territories are usually far larger than those of blackbirds, presumably reflecting the difficulties the birds have in finding adequate food supplies in their harsher environment. Upland pairs usually choose stretches of land with occasional crags and isolated trees (often rowan or mountain ash) that serve as song posts for the male, and with some sheltered cwms and gullies in which to build the nest.

Although often conspicuous in this habitat, especially since they choose prominent singing perches, they are far shyer in the presence of man than their lowland cousins. On the ground, they have the same jaunty gait, scampering over the grass, then pausing briefly to look and listen for food, flicking the wings and tail and occasionally cocking the tail high, especially immediately after landing.

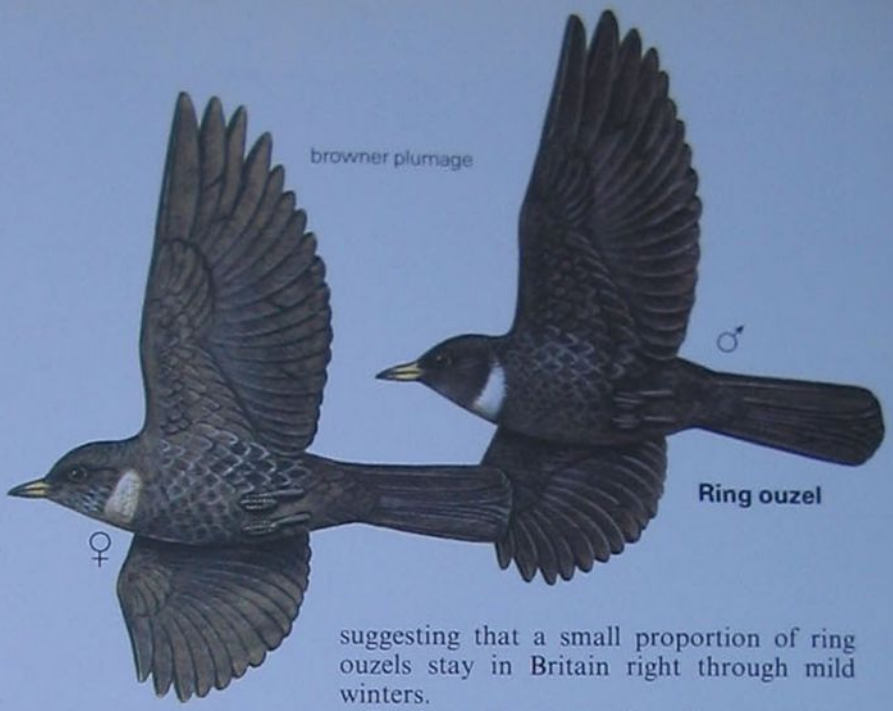
Whistling song The usual first clue to the presence of ring ouzels is either the song or the call. The song is a disjointed series of remote-sounding, penetrating whistles, some-

times single, sometimes double-phrased. Its simplicity adds to its penetrating power and range in the boisterously windy weather prevalent at high altitudes. There is a piping contact call, and a quietly scolding 'chuck, chuck', very like the call used by the female blackbird to keep her young under control. More characteristic, both on the breeding grounds and when flocks form in autumn, is a harsh, laughing 'tchack-tchack-tchack'.

Mediterranean migrants Our ring ouzels are migrants. It is thought that most of them winter in the Mediterranean basin. In autumn, when the southward journey lacks the urgency of spring migration and when numbers are swollen by the year's generation of young birds, ring ouzels may occasionally be found almost anywhere in lowland Britain where conditions are suitable for migrant thrushes. They choose sites where there is a plentiful supply of berries including elder, hawthorn, rose and rowan.

Ring ouzels of a Continental race are seen occasionally in autumn among the passage migrants recorded at the bird observatories around our coasts. These are Alpine ring ouzels, from the mountain ranges of central Europe, and they are characterised by a much more scaly, almost silvery body.

Because their migration is a relatively short one, ring ouzels are among the earliest of our summer visitors to return, many reaching the south coast bird observatories early in March, and arriving at their breeding grounds a few days later. Passage, including birds passing through Britain on the way to Scandinavia, may continue until early May. Return migrants begin to gather in flocks to meander southwards in late August and September, and a trickle of migrants often continues into November. There are also numerous reports



Above: Ring ouzels resemble blackbirds in size and shape. Their flight, however, is swifter and more direct, with wings beating almost continuously.

Ring ouzel (*Turdus torquatus*). Summer visitor resembling a blackbird with a white gorget. A few birds winter in lowlands. 24cm (9½in).

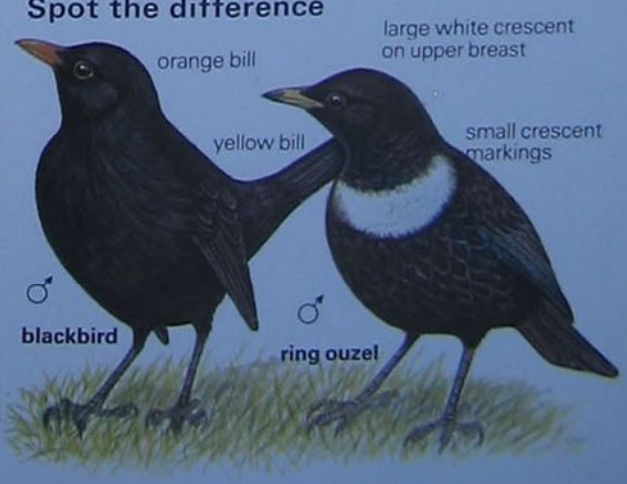
Below: The plumage of the male is sooty black, in contrast with the velvet blackness of the blackbird. The most striking feature is the white crescent on the upper breast.

suggesting that a small proportion of ring ouzels stay in Britain right through mild winters.

Finding a nest site Once back on their breeding grounds, the ring ouzel pairs quickly set about the establishment of a territory, which is loudly proclaimed by the male from his song posts, and fiercely defended by both birds calling harshly and 'dive-bombing' intruders, be they crows, stoats, foxes or even innocently straying humans or mountain sheep. The nest is made of coarse grasses, heather and a good deal of mud; and it is lined with soft, fine, dry grass. It is most often built in a crevice or on a rock ledge on a small crag or fall of scree. Almost as common are nests in low vegetation (below 46cm/18in), and some are even built directly on the ground.

One feature common to most ring ouzel nests is that they command a wide view of the surrounding countryside for the sitting bird to survey, and another is that they often have an overhang close above, offering some protection from inclement weather. Occasionally birds use crevices in deserted barns or mine buildings as a substitute for crags, and there are several descriptions of nests actually below ground level in old mine shafts, the lowest being 5m (15ft) down. In contrast, very few nests indeed are reported more than 1m (3ft) above ground in trees, the maximum

Spot the difference



Left: During the breeding season, much of the ring ouzel's food consists of earthworms, insects and their larvae, and small snails. Fruits of various plant species become a more important food source when autumn approaches.

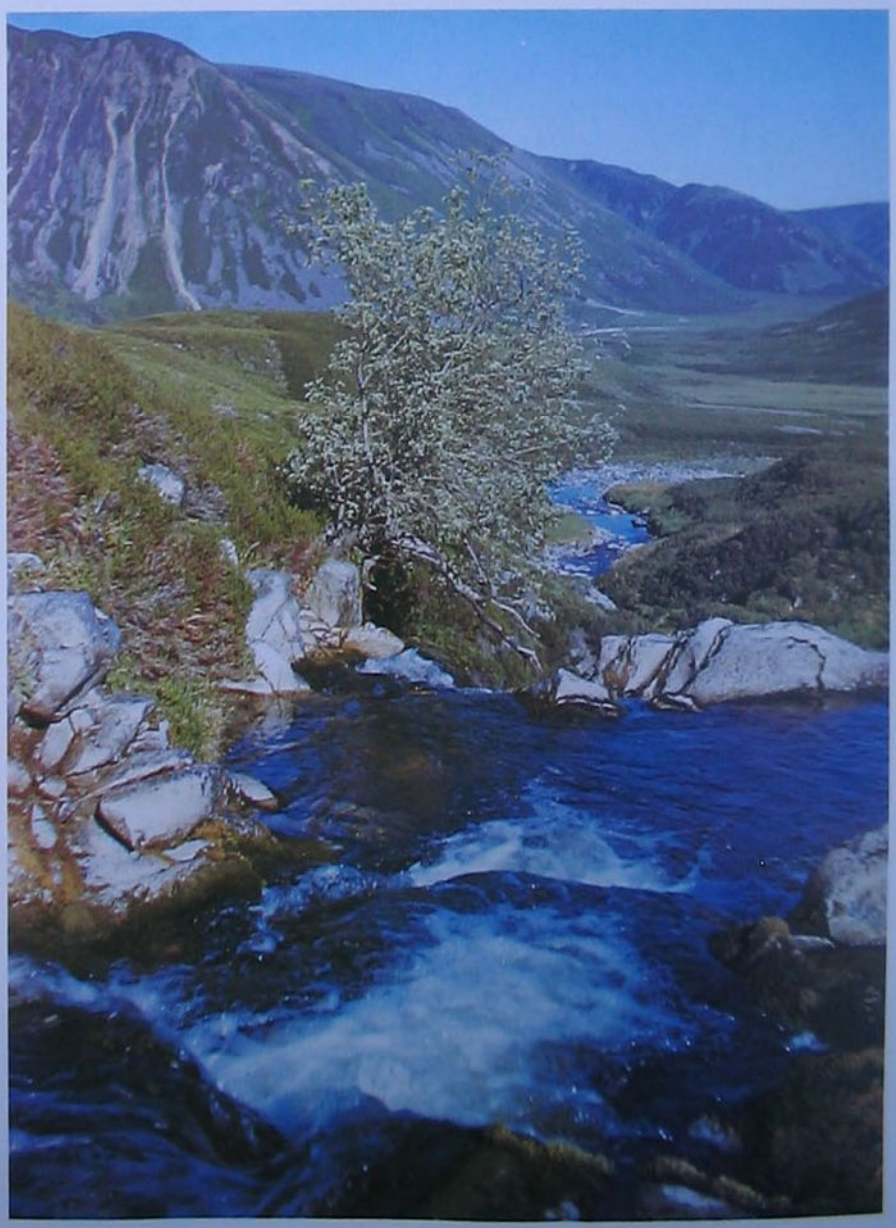
Below: The rushing burn above the Corrie Bhrodain waterfall in Inverness-shire. Here in the Grampian mountains the ring ouzel is at home. In the far north a few pairs nest at lower altitudes, even down to sea level; but over 80% of nests found in one recent study were between 230 and 530m (750-1750ft). The highest nest recorded was at a staggering altitude of 1140m (3750ft) in the Cairngorms.

on record being 3m (10ft) up in a tree.

Raising the brood The first eggs are laid in mid-April, with a distinct peak in egg production at the end of April and early in May below 450m (1500ft). Above this altitude, egg laying seems to occur later (as would be expected for climatic reasons)–perhaps by a week or ten days. There are indications that while first clutches lost are replaced, true second clutches are not common. Accurate timings of incubation and fledging periods are hard to obtain, perhaps not surprisingly in the light of the remoteness of most ring ouzel nests, but the indications are that each may last about a fortnight.

The great majority of clutches are of four eggs, pale blue in ground colour with a peppering of bold dark brown and lavender spots. Some clutches of three or five eggs are reported each year, but six is most unusual. Egg losses tend to be either single ones that prove to be infertile, or whole clutches lost either because of desertion or in the raids of predators.

Declining numbers It is clear from Victorian bird books that in the last century ring ouzels were both more numerous and more widely distributed than they are today, and that in some areas there has been a considerable decrease. Reasons for the decline are not obvious: certainly the ring ouzel seems well able to tolerate the relatively limited intrusions by man into its habitat. There has been a ···ggestion that the increase of the blackbird uring this century has adversely affected the ing ouzel, possibly with the additional influence of a milder climate–favouring the blackbird and reducing the area of the ring ouzel's montane habitat. The most recent estimate puts the population at between 8000 and 16,000 pairs.



KNOW YOUR WILD ONIONS

Onions–and the closely related leeks, chives and garlic–are among our most important culinary plants. Their ancestors can still be seen growing in the wild, all having the same distinctly sharp aroma of the garden species.

Below: A cluster of wild chives (*Allium schoenoprasum*), still in bud. This is the only cultivated onion that is also a British native, garden chives being virtually unchanged from their wild ancestors.

The lily family contains some of our most attractive flowering plants. The bluebell, for example, is the commonest lily–and certainly one of the most beautiful–in the British flora. But the largest group of species in the lily family, at least in Britain, is the genus *Allium*, the wild onions.

World wide, there are about 600 different species of wild onion, many of which are important culinary plants: garlic, leeks and chives as well as onions themselves are all members of this genus. Most species of wild onion occur in the temperate regions of the Northern Hemisphere, in the Old World and the New, but only one species is found on both sides of the Atlantic. This is wild chives, which is widely distributed through Europe, Asia and North America.

In Britain there are eight species of wild onion, of which just two–ramsons and crow garlic–are common. At the other extreme, the round-headed leek is one of our rarest plants since it grows only on limestone rocks in one area of the Avon Gorge near Bristol. Not surprisingly, it is protected by law.

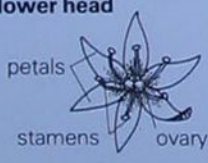
Distinguishing features The most obvious characteristics of plants in the genus *Allium* is their smell, which is always immediately recognisable as that of either onion or garlic. The odour is caused by the presence throughout the plant of sulphur-containing chemicals, which are released only when the plant is bruised or damaged.

Right: One of the most common onions in western Britain, ramsons (*Allium ursinum*) has white flower heads. However, though a delight to the eye, ramsons are also an offence to the nose: when bruised they smell extremely pungently and the smallest quantity eaten by a cow is enough to taint its milk. Ramsons used to be gathered and eaten as a relish but its taste is rather too powerful for modern palates.

Opposite right: One of the rarer species of onion native to Britain, the sand leek (*Allium scorodoprasum*). This is one of the onion species whose flower heads bear bulbils—miniature bulbs that are shed from the scape to grow rapidly into new plants. The scape grows to a height of about 80cm (30in) and then splits into two, revealing bell-shaped reddish-purple flowers and purple bulbils. The sand leek is found in northern England on scrub and grassland. It is occasionally cultivated for its bulbils and is then known as the rocambole.

Flower structure

flower head



close-up of flower

The individual flowers of onions are typical of the lily family, to which they belong, having six attractive petals and six stamens surrounding the ovary. Each flower can produce up to six large, heavy seeds. The flower shown here is that of ramsons.

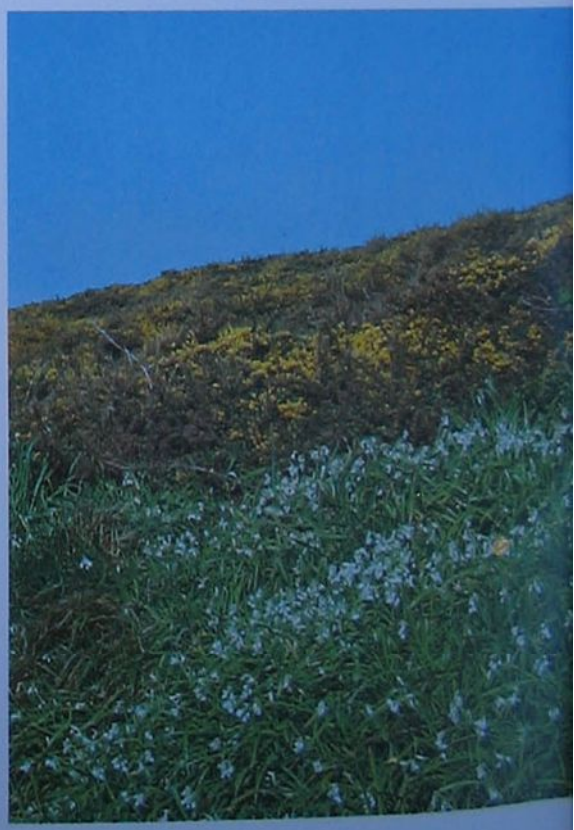
Another familiar characteristic of plants in this genus is that they all grow from a bulb, an underground collection of fleshy leaf-bases that surrounds next year's bud. In many species, small offsets grow around the bulb so that a dense clump of plants is built up.

All onions bear their flower heads on an upright unbranched stem called a scape. While the scape is growing, the flowers remain enclosed in an envelope, called the spathe, so that the scape appears to have a single spear-shaped bud. The spathe eventually splits open to reveal the flowers, whose stalks radiate from the top of the spathe. This type of flower head is called an umbel. Once it has split open, the spathe dries out and shrivels, in many species falling off soon afterwards.

Starry ramsons The ramsons, or wild garlic, is one of our most common species of onion. In early May the woods and hedgerows of western Britain become covered with the pure white, star-like flowers of this species. The leaves of ramsons are broadly lance-shaped, up to 25cm (10in) long and very wide for an onion—as much as 7cm ($2\frac{3}{4}$in). The leaf stalks are twisted through 180 degrees so that what seems to be the upper leaf surface is actually the lower.

The flowers are succeeded by a mass of heavy, black ovoid seeds; the leaves and scapes rapidly collapse and the seeds fall to the ground. There they are collected and dispersed by ants, which are attracted by the edible seed coat. Ramsons relies almost exclusively on seeds for its reproduction, and rarely produces new bulbs.

Ramsons is most common in the west of Britain, though it is still widespread in the east, where damp woods and shady stream-banks are its habitats. It is absent only from the intensely cultivated land of the Fens and from the Highlands of Scotland.



Crow garlic This species looks very different from ramsons and it occupies a quite distinct

habitat, for it is a plant of open areas such as pastures and is particularly frequent on roadside verges.

The leaves are greyish-green and cylindrical with longitudinal ridges. They can grow to a length of 60cm (2ft), although they are only 2mm wide. The plants are most conspicuous in the spring, before the leaves become engulfed in the rapidly growing grass. In July and August the leaves fade and the flowering stems appear. The spathe splits open to reveal, not the usual umbel of flowers, but a crowd of tiny bulbs, called bulbils, packed into a dense spherical head. These miniature bulbs are shed from the scape and quickly grow into new plants. In some plants, a few flowers grow among the bulbils, and very rarely a plant with a complete umbel of flowers and no bulbils is seen. The flowers are small (about 5mm long) and pink or greenish-white.

A similar species to crow garlic is field garlic. It, too, grows in dry grassy places, mainly in eastern England, and produces flower heads bearing a few pinkish or greenish flowers and a small number of bulbils.

Rare wild chives This species–the only cultivated onion that is also a British native–grows in a few scattered localities in England and Wales. Its habitats are startlingly varied. In Wales, chives grows in dense masses on rocks along a short stretch of the River Wye and, for several months each winter, the plants are submerged under turbulent water. In England it occurs on clifftops in Cornwall. The plants from these two habitats are quite distinct. Riverside plants have tall flowering stems and dense masses of upright leaves, whereas clifftop plants are diminutive and hug the ground–an adaptation to gales.

Above: The most successful onion species to be introduced to Britain is the three-cornered leek (*Allium triquetum*), now naturalised and very common in Cornwall and Devon.

Right: Crow garlic (*Allium vineale*) is another onion that produces tiny bulbils instead of the normal umbel of flowers. Each bulbil is the size of a barley grain.

Below: Three-cornered leeks growing on a hillside, with gorse in the background.

The flowers of chives are bell-shaped with attractive petals of pink or pale purple.

Localised leeks Two species of leek grow in Britain. The wild leek is found close to the sea in a few places in south-west England. It is a massive plant with strap-like leaves 60cm (2ft) long and up to 3cm (1¼in) wide, distinctly keel-shaped on the back. The flowering stem is sturdy and rises to a height of 2m (6ft).

Britain has two distinct varieties of wild leek. In one the plants have a compact, many-flowered umbel, while a form known as Babington's leek bears round bulbils with a few long-stalked flowers in between. Both varieties have bulbs, although the cultivated leek (which has been selected from Mediterranean plants of the same species) is no longer able to form a swollen bulb.

The other British species of leek is the sand leek, a plant of grassland and scrub with flat, keeled leaves. It grows only in northern England.

SLOW-WORMS: LEGLESS LIZARDS

Slow-worms are neither slow, nor are they worms. They are lizards without legs. Nor, despite their appearance, are they snakes: they can break off their tails to escape capture, and they can close their eyes–snakes can do neither of these things.

Above: A female slow-worm, basking in the sun to warm the young she is carrying.

Above right: This blue-spotted male slow-worm was unearthed in winter–it is in a typical 'curled' hibernation position.

The slow-worm is really a lizard, one of the three lizard species found in Britain's countryside. It is one of the most widely distributed lizards of Europe, found within reach of the Arctic Circle (in Scandinavia) and also throughout most of mainland Europe, extending eastwards to parts of south-west Asia. Its British distribution is wide, for it occurs in many parts of mainland England, Scotland and Wales. It is also found on some of the small offshore islands, though not in Ireland.

Not a snake Slow-worms were at one time thought to be snakes. We now know that they are lizards, and indeed that throughout the world there are many kinds of lizards that do not have limbs. Although the slow-worm has neither front nor hind limbs, it does possess vestiges or remains of the pectoral limb girdle, the assembly of bones inside the animals to which the front legs would normally be attached. The slow-worm has a number of features which are characteristic of lizards, and these include movable eyelids, a detachable tail and a broad, flat tongue. Generally speaking, snakes do not have movable eyelids, nor do they have tails which can be detached, and a snake's tongue is long and pointed or forked.

Elegant reptile The scales of a slow-worm are smooth and polished, and are basically brown or grey in colour. Many of the males have a fairly uniform coloration; some are made quite beautiful by the presence of blue spots. Blue-spotted slow-worms are not uncommon but the cause or the function of the blue spots is not fully understood.

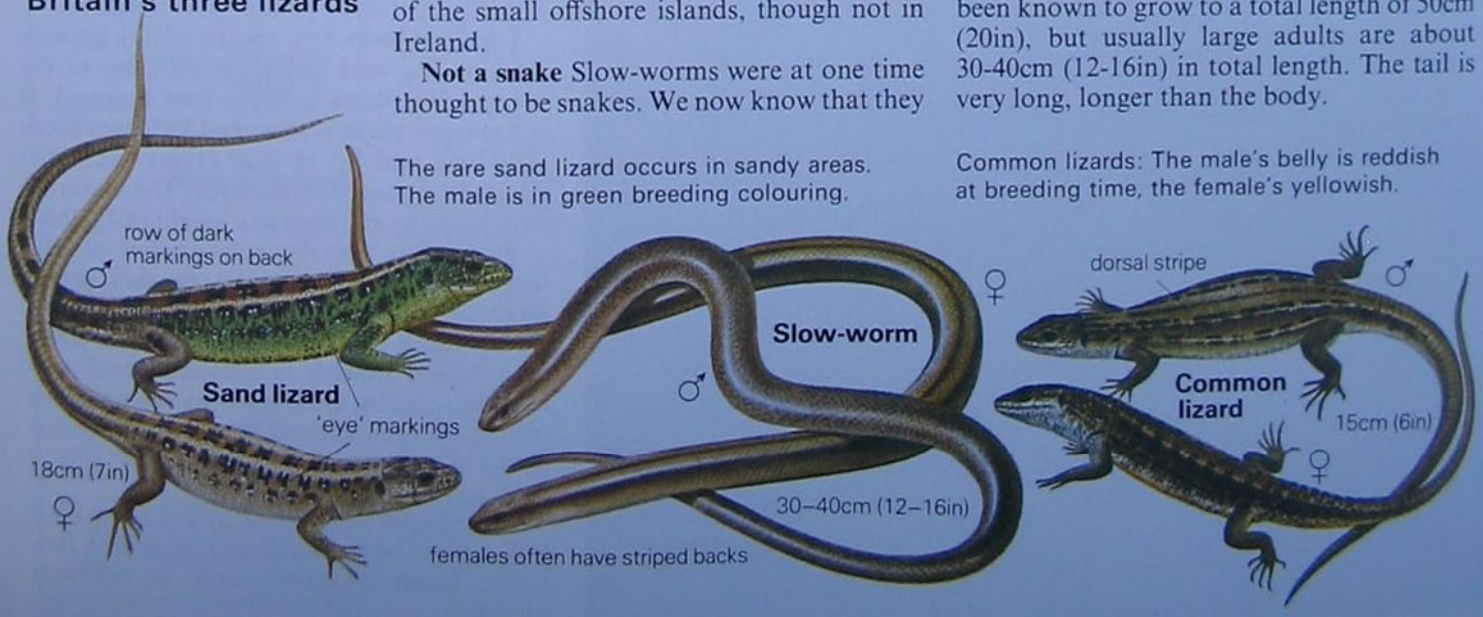
A female slow-worm is usually dark brown or chocolate underneath, dark brown on the sides and light brown on the back. Many of the females have a dark coloured stripe running down the back.

The detachable tail Some slow-worms have been known to grow to a total length of 50cm (20in), but usually large adults are about 30-40cm (12-16in) in total length. The tail is very long, longer than the body.

Britain's three lizards

The rare sand lizard occurs in sandy areas. The male is in green breeding colouring.

Common lizards: The male's belly is reddish at breeding time, the female's yellowish.



The scientific name of the slow-worm is *Anguis fragilis*; the first part, *Anguis*, means snake-like while the specific name, *fragilis*, refers to its ability to detach the tail. It shares this ability with many other lizards, and there is a technical word for it–autotomy. On many slow-worms the tail is found to be regrown as a result of tail autotomy. Loss of the tail or part of the tail causes no harm to the slow-worm, and indeed the ability to lose part of the tail is a good means of escape when caught by a predator. A tail that has not been broken is quite easy to recognise, because the tip, which consists of a single terminal scale, is sharp and pointed.

Emerging in spring During late February or early March, if the weather is mild, slow-worms begin to leave their underground winter refuges. Common lizards also emerge at about this time, but whereas common lizards regularly bask in the sunshine for long periods of time, slow-worms are more secretive and bask on few occasions. For much of the summer they spend their time hidden in the grass or below the soil surface.

There are, however, two periods during the year when slow-worms are found basking. Very soon after emerging from the winter site, the males tend to spend some of the time basking. They favour sites on warm, sunlit banks or on large tufts of grass. Later in the year, during July and August, the gravid females (females that are about to give birth to young), are seen basking for short periods of time. By basking in the sunlight the females are able to increase their body temperature to about 16°C (64°F), and this temperature increase assists the development of the unborn young.

Slug eaters In captivity, slow-worms are usually fed on slugs, insects and worms. In the field, they have been observed to catch and eat slugs, apparently preferring small white slugs when available.

A long life Although slow-worms seem to live for many years, little research has been carried out to investigate their longevity. One slow-worm, kept in the Zoological Museum at Copenhagen, survived for the extraordinary time of 54 years. Other captive specimens have lived for 25 or 30 years. Certainly, slow-worms can live for a long time, but their life expectancy in the wild would be much less than 25 years. Their growth to full size is slow, taking several years.

Dwindling numbers Although the slow-worm is fairly common and well-known, there has been a gradual decline in the number of places where it can be found. The countryside is for ever changing, and it is perhaps not surprising that these lizards, together with other animals of similar habitats, are dwindling in numbers. However, there are still many sites where you have a good chance to see a slow-worm. The edges of forest rides, hedgerow banks and other undisturbed grassy areas are all good places to look for slow-worms.

Above: An example of the habitat of slow-worms. They are able to burrow in soft earth and seem to prefer habitats which are well vegetated, moist and warm. Old, undisturbed grassland is a likely place to find them, and so also are hedge banks, the sides of ditches and railway embankments. Long grass on road verges attracts slow-worms, as do undisturbed gardens–provided there are no cats.

Left: Young slow-worms, still encased within the membrane in which they were born. They break open the membrane within about a minute, and immediately begin to move about. The new-born slow-worms are very slender and about 8cm (3in) in total length. They are golden yellow, with a black stripe along the back and black sides and undersides. Usually, about 10 young are born, although very large females have been known to give birth to as many as 20.

THE GRACEFUL WEEPING WILLOW

Such an integral part of our lowland landscape is the weeping willow that it is hard to imagine our parks and riversides without it. Yet this tree is not native to the British Isles, being introduced here less than 200 years ago.

Above: The distinctively pendulous shape of a golden weeping willow, in Britain the most widely planted weeping tree of any kind. The tree shown above was photographed in early spring, still in flower.

Two quite separate species of tree are commonly known as the weeping willow. Both were introduced here from abroad – a surprising fact when you consider how naturally suited they are to the riverbanks and parks of lowland Britain. Yet neither species can even be considered as naturalised here, for they cannot propagate themselves on their own; they can spread only with man's help.

Chinese weeping willow The first species of weeping willow to reach Britain is now by far the rarer of the two. This is the Chinese weeping willow (*Salix babylonica*), brought over here during the 18th century. It was named *babylonica* by the Swedish botanist, Linnaeus, who thought it was the tree referred to in Psalm 137:

> 'By the rivers of Babylon, there we sat down, yea, we wept, when we remembered Zion. We hanged our harps upon the willows in the midst thereof'.

However, it now seems more likely that the tree in question is a species of poplar.

The precise origin of the Chinese weeping willow is still uncertain. It has been in cultivation in western Asia and Europe for centuries, but the plant is not native to these regions and it is thought to have come from western China, spreading westwards via the traditional trade routes.

The Chinese weeping willow made its first

appearance in Britain when it was planted in Twickenham Park in the 1730s, reputedly by a certain Mr Vernon. A more fanciful story tells that the poet, Alexander Pope, raised the first weeping willows in this country by planting the ropes used to secure a parcel sent from Spain to a friend of his.

New arrival Once introduced, the Chinese weeping willow rapidly became popular and was quite widely planted. However, it has never really thrived in this country because it is not well suited to the British climate. Today, it is rare in Britain, having been superseded by the golden weeping willow.

This species also has an obscure origin, a fact reflected in the number of different names by which it is known, such as *Salix alba* 'Chrysocoma' or 'Vitellina pendula'. Nowadays, many authorities feel that its correct name should be *Salix* × *sepulchralis* and it is regarded as being a hybrid. Its parents are thought to be *Salix alba* subsp. *vitellina*, a form of the white willow with yellow twigs, and the Chinese weeping willow, from where it gets its conspicuously pendulous habit. It was introduced to Britain from France in about 1800.

Similarities and differences Both the golden and the Chinese weeping willows form graceful trees with long, pendent, recurving branches reaching down almost to the ground. The former grows to a height of 15m (50ft), while the latter can reach a little higher – up to 20m (65ft). The bark of the golden weeping willow is brownish-grey and criss-crossed by shallow grooves and ridges. That of the Chinese weeping willow tends to be more brownish and deeply grooved.

Both trees have the same form of leaf: narrow and lance-shaped with a pointed tip, fine teeth and a short stalk. On the golden weeping willow the leaves can be up to 10cm (4in) long and the lower leaf surface bears very fine hairs, making it appear whitish in contrast to the shiny pale green of the upper surface. The leaves of the Chinese weeping willow tend to be shorter and lack the downy undersurface. The leaves appear very early in the year, usually in February, and remain on the tree until late in the year, sometimes not being shed until December.

Yellow catkins In common with other members of the willow family (which includes poplars and the aspen as well as willows themselves), the flowers of both species of weeping willow are borne in catkins, males and females appearing on separate trees. In both willows the catkins are yellow.

On the Chinese weeping willow the catkins are about 2cm ($\frac{3}{4}$in) long and the female flowers have a nectar-producing gland, called a nectary, to attract pollinating insects – moths and bees being particularly attracted. The pollen grains produced by this and other willows are extremely small and light, light enough, indeed, for the Chinese weeping willow to be pollinated by means of the wind.

By contrast, only male forms of the golden weeping willow are ever seen in this country. This means that the catkins are always male (though occasionally mixed catkins containing a few female flowers occur). Whether pure or mixed, the catkins are slender and about 8cm (3in) long.

Because of its almost complete lack of female flowers, the golden weeping willow has hardly any chance to set seed – though, being a hybrid, its seeds would most likely be sterile in any case. Consequently the tree can be propagated only by cuttings which, fortunately, take root very readily – as do those of many other willows.

Although the Chinese weeping willow has become a rarity in the British Isles, the golden remains one of our most popular decorative trees. Indeed, the attractiveness of many stretches along such rivers as the Thames and the Cam owe a great deal to the planting of this willow. It is difficult to imagine now that this tree has been in Britain for less than 200 years, so much is it a part of our lowland scenery.

Above: Summer and winter outlines of the Chinese weeping willow, with the catkins of the much more common golden variety. The two trees are very similar. The only major differences are that the leaves of the golden weeping willow are downy underneath and its catkins are much longer than on the Chinese species.

Chinese weeping willow (*Salix babylonica*). Deciduous tree, native to western China. Introduced around 1730, but now rare. Height to 20m (65ft).

Golden weeping willow (*Salix* × *sepulchralis*). Deciduous hybrid, introduced around 1800. Height to 15m (50ft).

Below: The ridged bark of a golden weeping willow.

SPRING: NEW LIFE IN THE COUNTRYSIDE

The arrival of spring around the beginning of March is eagerly welcomed after the long, dark days of winter. The lengthening days and warmer temperatures trigger plant growth, from early dawn birds proclaim their territories, and all kinds of other animals are revitalised as the new year begins.

In spring the strengthening sun begins to release winter's grip on the countryside. To the meteorologist, spring is from March to May, and it is a period of instability. This is because the ground is warming up but the air is still quite cold, producing a bittersweet mixture of squally showers, fine spells and cold, frosty nights. Just when the days appear to be improving, a deep depression can whip moisture-laden air down from the polar seas, hurling it on the countryside as sleet and snow. Thus, after warm March days, when the blackthorn comes into bloom, there is often a sting in the tail of the month – the blackthorn winter of March 29-31. Thereafter, the setbacks are steadily fewer as the unsettled weather develops into the milder, showery pattern of April – just what is needed to stimulate dormant vegetation into action.

Plant growth is triggered and can be sustained whenever the mean temperature rises to 6°C (43°F), which, in the British Isles, is regularly reached in March. It is the variation around this critical threshold that makes spring such a fickle period for plants. While a north-facing roadside verge may sleep on in the chill until late March, the south side, basking in the sun, may produce celandines as early as January. Even so, celandine flowers have a short day, barely opening before 9am and closing up by 5pm.

While rising temperatures promote general growth, the lengthening days have special significance for the flowering process itself. Some plants flower only when the daylength falls within certain limits, and spring flowers are therefore in the category of 'short-day' plants, requiring less than 12 hours of daylight to bloom.

The celandine, in common with many other spring flowers such as snowdrops and daffodils, has an underground cache of nutrients in the form of bulbs, which can galvanise the plant into action as soon as the soil begins to warm up. Long after the flowers themselves have died, the leaves continue to manufacture nutrients which are absorbed into the bulb for the next spring. To withstand frost, the leaves themselves are tough and fibrous or, as in the crocus, needle-like and protected by a thick cuticle.

Many spring plants, the primrose for instance, form cushions or clumps which conserve the sun's frugal warmth, hastening growth. Decaying plant litter is also a good insulator which generates some heat of its own. Beneath a thick bed of litter, therefore, spring effectively begins a few days earlier for plants such as ground elder and ground ivy, the rosettes of rosebay willowherb and the spear-shaped leaves of lords-and-ladies (also known as arum and cuckoo-pint). A few

hardy trees, such as elder, also respond quickly to the first hint of mildness, and sprout tentative leaves in January and February. One of the earliest to leaf, the horse chestnut sheathes its swelling buds in sticky resin against damage by frost. The leaves of most deciduous trees are vulnerable when they first emerge; initially lacking the woody compounds called lignins, which are built up over the summer to resist attack by insects, the nascent leaves of the beech, for example, are beautifully tender and transparent. The new leaves of some other species, such as the oak and the sycamore, are diffused with red pigment which may act as a protective filter against intense spring sunlight, and especially against ultra-violet radiation.

Several trees flower well before they leaf, giving us one of our most cherished symbols of the advancing year – the 'pussy' willow. Tree species adopting this pattern include hazel, poplar, aspen, alder and hornbeam. The male and female flowers are often borne on separate trees and the pollen is wind-dispersed. Because most of it falls by the wayside, pollen is produced in vast amounts, frequently in long, pendulous catkins; in addition, each pollen grain is typically provided with an air sac, helping it to remain airborne for up to 20km (12 miles). Larch is also wind pollinated and flowers early (for a conifer) at the beginning of April.

The willows, well-known for their attractive early catkins, differ from these other species in being insect-pollinated. They provide an eagerly sought-after bonanza of pollen and nectar, at first for queen bumblebees newly emerged from hibernation and later on for other sorts of bees and flies. By flowering so lavishly, the willows are guaranteed a generous stream of insects, even in March, and so are efficiently pollinated.

The great majority of spring flowers also depend on insects to carry pollen from one to another. The primrose and the deadnettles are very attractive to bumblebees and, since the primrose stays open at night, it welcomes moths as well. For many primroses, however, the pollinating agent is the bee-fly, a robust furry fly with a remarkably long proboscis capable of tapping the flower's deep nectaries.

The fact that many spring flowers are pollinated not by bees, which emerge relatively late, but by moths, flies and beetles, explains why, compared with summer, red and blue flowers are much less common in spring than, say, white and yellow ones. The vision of bees, but not of the insects listed above, is especially sensitive in the red-blue (and ultra-violet) spectrum, so summer flowers, by evolving these colours, attract the bee multitude to them.

The brimstone, first of the butterflies to emerge from hibernation, flutters from the evergreen where it has spent the winter. The male is lemon yellow, the female greenish white. Another early flyer, the orange-tip seeks its crucifer food-plant, notably jack-by-the-hedge, in which to lay its eggs.

Scores of less exotic insects are also on the move, and the annual cycle begins in earnest. Ladybirds begin hunting for aphids, their staple diet; queen wasps scrape laboriously at fence-posts and shed doors to furnish wood-pulp for nest-building. Others pounce on the barely wakened trees, leaves and buds, gall-wasps attacking buds from the outside, sometimes to meet newly hatched caterpillars munching from within. On warm March days a host of March-fly pupae hatch in squadrons of rather sinister-looking black insects. Slow flyers, with dangling legs, March-flies are snapped up by birds.

Some ground-beetles have a special bonus diet – the spores of a select band of spring fungi. Of these, the best known, though by no means the most common, is the morel, unmistakable with its bizarre honeycombed cap; it is found in open woodland, hedgebanks and sometimes gardens, notably on chalky ground. Morels are highly palatable, not only to man but also to squirrels and badgers.

Also edible, but less tasty, is the St George's mushroom, so-called for appearing around the Saint's day on April 23. It forms striking

'fairy rings' on chalk grassland as, however, do some closely related poisonous species, so identification here is best left to the experts. St George's Day is also traditionally the time to collect dandelions, then at their best, for wine-making.

The moist March night that favours the growth of morels is just the sort awaited by toads to converge on their spawning ponds. If you sit by a pond as daylight is just failing, everything is still and nothing out of the ordinary seems about to happen; but suddenly all the toads which have been laid up for the day near the pond emerge from hiding and begin advancing purposefully towards it. Around the pond's edge there is mayhem as ardent males compete to waylay the females even before they reach the water.

A similar mating urge pervades the entire cold-blooded kingdom of amphibians and reptiles. Frogs resort to water from late February onwards, and newts quit their winter quarters in March. Reptiles need higher temperatures to stir from their underground retreats. In mid-April vipers, which have overwintered communally in a tangled mass, slither dozily out to bask and moult together in the sun. When the females surface a couple of weeks later there is a mad scramble for mating rights. The males are now highly mobile in search of mature females, and they indulge in ritual combats in efforts to gain supremacy over their rivals. Some fall prey to recently awakened hungry hedgehogs.

Badgers, being omnivorous, are quite capable of despatching a hedgehog – the rarity of hedgehogs in some woods is attributed to the healthy badger population there. Badgers dig out bumblebee nests for the juicy bee grubs inside. Ever busy, the badger also tends to domestic chores, cleaning the soon-to-be-needed nursery in its sett. A tell-tale litter of dried grass and leaves around the entrance reveals that the badger has been hauling out the soiled winter bedding to replace with a fresh lining.

High in the trees in late March rooks are busy repairing nests with a great deal of squabbling over choice twigs. They are preceded only by tawny owls, which may already be sitting on eggs in late February. Many insectivorous birds, such as tits and robins, cannot begin nesting until April or May when their diet of caterpillars is accessible from opening buds. Each species starts nesting at an allotted time, when its particular kind of food becomes abundant enough to meet the extra energy demands of laying eggs and raising a brood.

To meet these special needs, birds are prepared to travel enormous distances. Spring is therefore a time of frenzied reshuffling as many, such as redwings and fieldfares, now return to breed in a northern Scandinavian spring in May and June. Meanwhile, hordes of migrants pour into the British Isles from the tropics. Many waders, such as the knot and grey plover, pass hastily through en route to Arctic breeding grounds.

For many others, however, Britain is the goal. The arrival in late March of the chiffchaff heralds the immigrant influx of warblers, while the sand-martin leads the tribe of swallows and martins. The coastline, too, is filling up with flocks of terns and skuas from the far south, the Arctic tern journeying 12,000km (7500 miles) from Antarctica. Gulls and auks, which have been dispersed offshore all winter, also assemble at traditional breeding colonies. Puffins prospect old nest burrows or work furiously to dig new ones.

Ringing studies have shown that, notwithstanding the complexities of navigation, most migrants, if they survive the winter, return to the very spot they occupied the previous year, often the self-same nest. Competition among breeding birds for space and food, heightened by this invading army, is reflected in one of our best-loved phenomena, the dawn chorus – a lusty proclamation of territorial ownership, often started by the dunnock and the robin well before sunrise. Within half an hour their duet is swelled by a torrent of song. Come late April, a new voice is added – the measured fluting notes of the cuckoo, signalling summer.

Above: Female great wood-wasp (*Urocerus gigas*). Length 4cm (1½in). Black thorax, yellow abdomen with broad black band.

Above: Male great wood-wasp. Length 2.6cm (1in). Black thorax and entirely orange abdomen. Does not have an ovipositor.

Above: Female *Sirex noctilio*. Length 2.5cm (1in). Dull bluish-black in colour with a particularly short ovipositor.

WOOD-BORING WASPS: HARMLESS HORNTAILS

Wood-wasps – also known as 'horntails' – are found in coniferous plantations where their larvae feed on wood tissue in tree-trunks and branches. The females, which are seen most frequently, have particularly long ovipositors that are easily mistaken for stinging organs – they are, however, harmless.

You are most likely to encounter wood-wasps – members of the family Siricidae, which forms a division of the Hymenoptera – in mature pine plantations where tree-felling has taken place. There are three well-established species in Britain, and all are associated with coniferous trees where they may be seen resting on the trunks and branches or flying in the sunshine making a loud buzzing noise. They appear to prefer trees which are weakened by the attack of defoliating caterpillars, or timber which has been felled and stacked in the open.

Wood-wasps are large insects. The females, which are more common than the males, have prominent ovipositors (egg-laying organs) at the ends of their bodies which resemble stings and give them a formidable appearance, although they are in fact quite harmless.

Wood-boring females Wood-wasp larvae feed in pine, spruce, silver fir and larch wood, apparently without any preference, although the larvae of great wood-wasps tend to choose larger logs and trees.

When laying her eggs, the female moves across the tree-trunk in a spasmodic manner, constantly tapping the bark with her antennae. On finding a satisfactory place she raises her body high on her legs and then slips her thin ovipositor from the two halves of its sheath into the bark. She bores into the wood by sawing with her ovipositor until it is completely inserted.

The first egg is placed at the bottom of the bore-hole and the others are laid as the ovipositor is slowly withdrawn. The entire operation takes about ten minutes and three or four eggs are usually laid in each bore-hole.

Occasionally you may find a dead wood-wasp with its ovipositor embedded in the wood. The unfortunate female was probably unable to withdraw it, either because she

Top left: If you watch patiently in a coniferous plantation you may be rewarded by an encounter with a female great wood-wasp laying her eggs. You are most likely to find her on a large log or tree, moving in a jerky manner and constantly tapping the bark with her antennae. On finding a suitable spot she raises her body high on her legs and then bores into the bark with her ovipositor. This is effected by a rapid sawing movement which continues until the entire ovipositor has been inserted. She lays the first egg at the bottom of the tunnel, and the others as the ovipositor is withdrawn.

chose a tree which was too healthy and the wood tissue closed around her ovipositor, or because she was nearing the end of her life and too weak to complete the vigorous egg-laying operation.

Fungi-ridden burrows After hatching, the larvae initially tunnel in the outer sapwood, and then eat their way towards the centre of the heartwood. Two and a half years later the fully fed larvae bore outwards to within a few millimetres of the bark and pupate. The adults thus have only a small thickness of wood through which to bite a passage to the outside world.

The larval burrow is always infested with a fungus which is probably essential to the larva's feeding. When the female lays her eggs in the narrow bore-hole she releases fungal spores from a gland at the base of her ovipositor. These spores develop into fungi which chemically break down the wood tissues, making them easier for the larva to digest.

Pest or not? Although sometimes considered as pests, wood-wasps do little harm to living trees. Since the larvae feed on unhealthy trees, the presence of wood-wasps is in fact a help to the observant forester as it indicates the health of his trees–whether they are infested with disease or planted in unsuitable localities.

Wood-wasp larva may, however, seriously damage logs stacked in the open, as the burrows, when large, are sufficient to spoil the timber.

Wood-wasp species Of the three established species in the British Isles, the commonest is the great wood-wasp. The males are mysteriously rare, but the females are often seen and attract attention by their large size, a quarter of which is accounted for by their very noticeable ovipositors.

The female has a black head with a yellow patch beside each eye and yellow antennae. Her thorax is black while her abdomen is yellow, except for a broad black band covering the second to fifth abdominal segments. She has no constriction or 'waist' between the thorax and abdomen and her wings are clear, with a slight brownish tint. The male is smaller with an orange-yellow abdomen, and (of course) lacks the ovipositor.

In the lesser wood-wasp the female is about 2.5cm (1in) long, and a shining, dark blue with a relatively short ovipositor. The rarely encountered male is yellow and black and resembles a smaller version of the male great wood-wasp.

The female of our third and least common wood-wasp, *Sirex noctilio*, is similar to the lesser wood-wasp but duller blue-black in colour, with an even shorter ovipositor; the male is black and yellow. Other species of wood-wasp are sometimes accidentally introduced from abroad with imported timber, but they never become widespread anywhere in the British Isles.

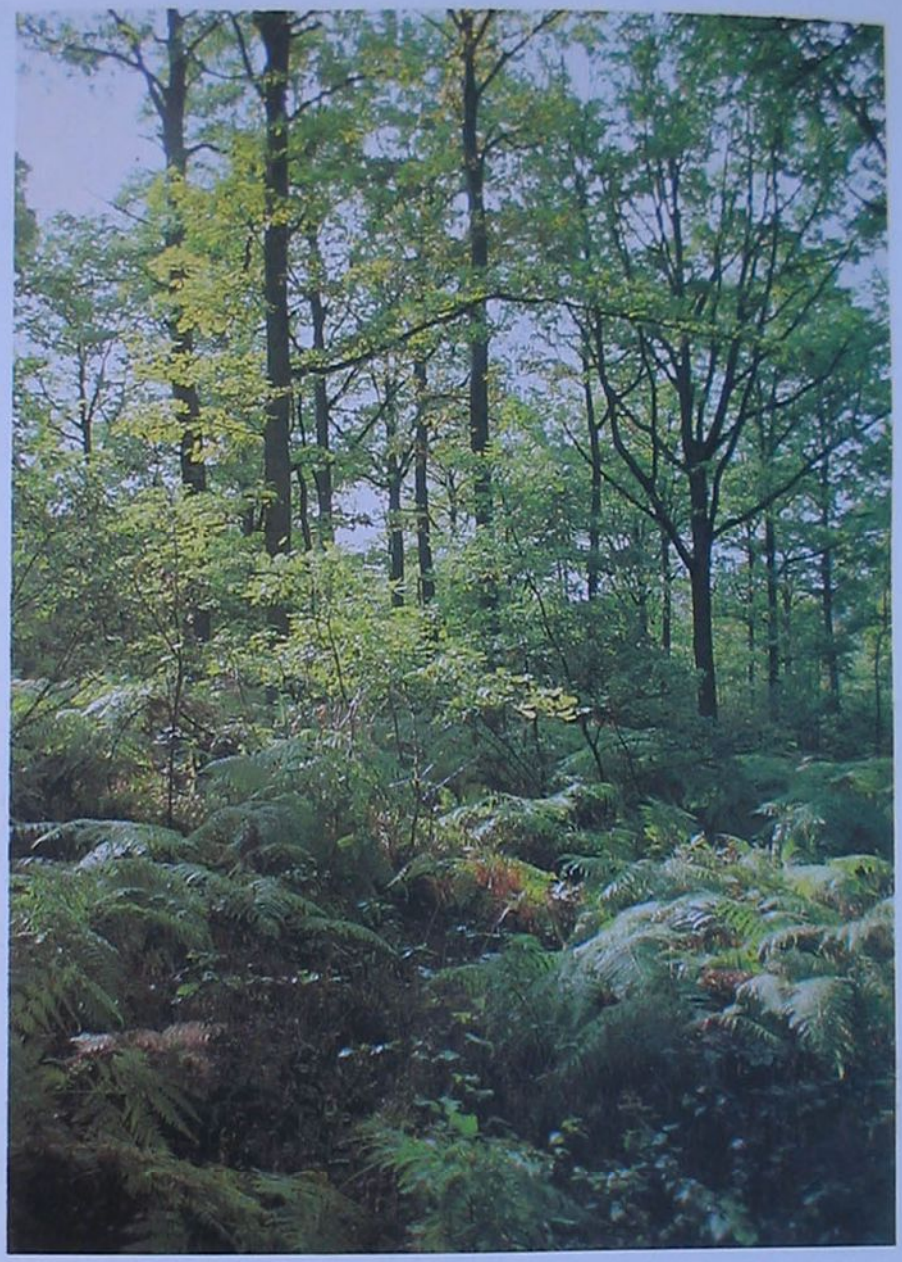
Above: The female *Rhyssa persuasoria* parasitises wood-wasp larvae. When searching for a host she crawls over the bark using her antennae and sensory organs on the tip of her ovipositor to detect larvae below the surface. On locating a victim she bores into the wood with her slender ovipositor (shown in the picture) and lays her eggs on the host.

Right: The wood-wasp larva pupates a few millimetres below the bark so the adult has only a small thickness of wood through which to escape.

Below: The female lesser wood-wasp is a shiny dark blue colour.

MANAGING A HABITAT

Good management of specially preserved areas of woodland (such as Wyre Forest), marsh and heath can provide valuable havens for many of Britain's wildlife species.



Places set aside specially for the study of wildlife are known as nature reserves and may take several forms. Some are looked after by County Councils and are known as local nature reserves, while others are in the care of the County Naturalists' Trusts and are bought with the help of members' subscriptions, as are the reserves run by the RSPB. The government agency responsible for conservation is the Nature Conservancy Council which, as well as managing its reserves, also commissions research into various aspects of conservation. While some reserves are acquired in order to protect plants or animals which are rare locally or nationally, others have a comprehensive range of species which typify a particular habitat.

Managing a forest The Wyre Forest National Nature Reserve in the West Midlands is a large area of oak woodland and coniferous plantations, among which are numerous old meadows and orchards. A trout stream runs through the valley into the River Severn nearby, and a disused railway track also runs through the forest.

Most of the oak woodland is of an even-age structure. The coppice areas where charcoal burning and bark peeling once thrived are long since abandoned. To introduce a more mixed woodland age structure, the oak is thinned to let in more light and allow other species of trees, such as birch and wild service, to regenerate. This may be standard forestry thinning, or an experimental type where various techniques are tried in order to favour trees which will be growing on well when the final crop of larger or more mature trees is felled. These techniques require heavy tree handling and are carried out by skilled contractors. The felled trees are usually converted into fence stakes or planking timber, if large enough; this will often pay for the work and provide a financial return for the owner. It helps if, in certain areas, an extra tree or two is removed to create a glade, where regeneration of oak, birch and heather will be much quicker, because of the extra light admitted. If possible, a few trees are ring-barked, causing them to die and thus

Above: Deep inside Wyre Forest National Nature Reserve. Because there is a limited supply of funds for conservation, much of the reserve's management is done by volunteers who may be naturalists or simply people who enjoy the countryside. Some of the larger and more important reserves, such as this one, have wardens—part of their job being to co-ordinate this use of voluntary help. Much of the work of cutting and clearing is done by parties of people from the Wyre Forest Society—a society which aims to preserve the beauty and conservation interest in the woodland of Wyre.

Opposite left: Columbines grace the forest in spring.

provide a valuable dead wood habitat. They may also be simply felled and left to die and rot where they fall.

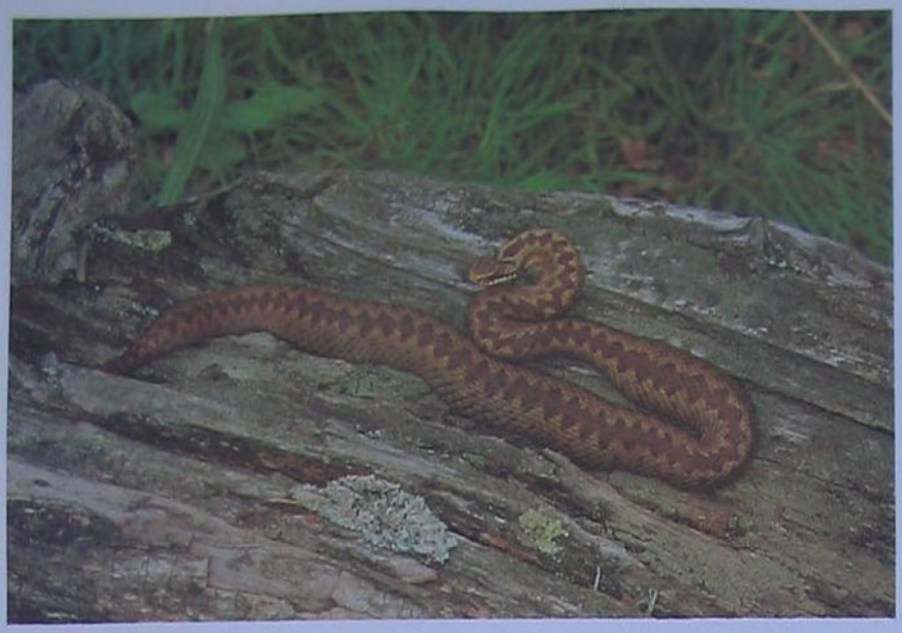
Certain species of birds can be attracted if nest sites are provided. If there are few natural nest holes, interesting species such as the redstart and the pied flycatcher readily use the nest boxes erected in the woodlands and orchards.

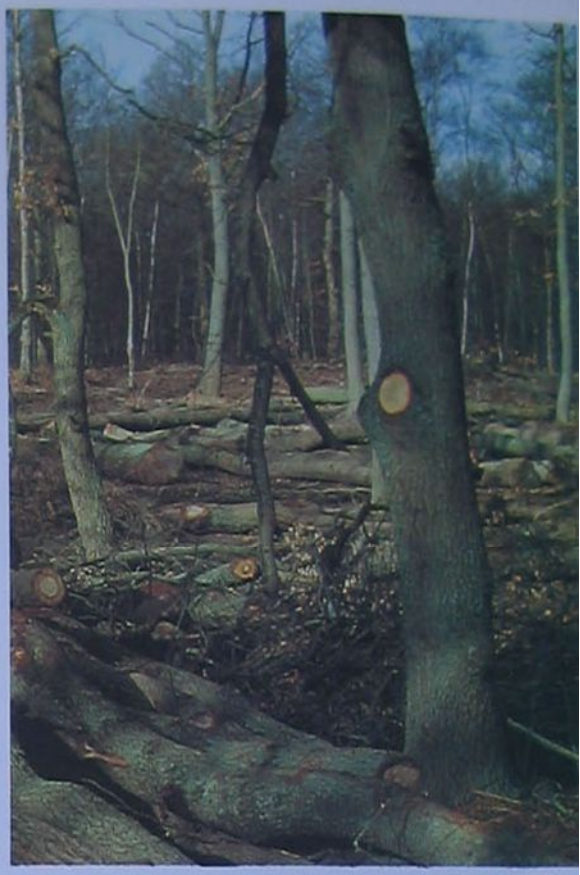
In areas where oak coppice growth is favoured, the younger stems may be cut and sold locally for use as bean sticks or for making rustic furniture, leaving a stem or two on each stump as possible future trees. These older poles may be sold as firewood.

Many of the thicker and even-aged oak woods are relatively devoid of interest deep inside; they often have a ground flora consisting mainly of bracken. A much more diverse range of insects and plants occurs, however, on the edges–here such species as bramble, hawthorn and rose form thickets in a dense border. A wide ride cut through a wood will create two such new edges, and this can give a great boost to the variety of species within the forest, provided not too much timber is removed in the process. Butterflies especially welcome these sheltered flyways, and such plants as bugle thrive.

Woodland scrub The woodland edge is really a scrub habitat and scrub is also found in other parts of the reserve. It is important for different groups of plants and animals at varying stages of its development. For example, warblers may need small blackthorn bushes of five years old or so in which to breed, whereas hairstreak butterflies need much older bushes on which to lay their eggs, while silver-washed fritillary butterflies prefer to obtain nectar from bramble blossoms. Good management must therefore ensure

Sights to see in Wyre Forest National Nature Reserve–cowslips in the meadows (above), a redstart (left) and bark peelings ready to go to a tannery (below). The landscape of Britain as we know it today has nearly all been shaped by man. Even the wild hill country moorland is a man-made scene, created by sheep grazing and heather burning. It is, indeed, almost impossible to find any true primeval habitat, although some areas may come close to it, such as the pine forests of Scotland and certain parts of the coastline. Often, though, especially in areas of intensive agriculture, our wild areas of woodland, marsh and heath have become fragmented or widely detached from their nearest area of comparable habitat. They have become oases, in fact, with few connecting lines along which wildlife can spread or extend in range. Many of the wild species still existing in these isolated pockets are rare, some being found in just one spot in the country. We have only relatively recently started to understand some of the complex inter-relationships existing between plants and animals. To learn more in this field of ecology, it is necessary to set aside areas where species can be studied in conditions which are as natural as possible–areas like Wyre Forest, where good management ensures species survival.





that such areas remain–but only so long as other species needing an open habitat do not suffer in the process. In a large area such as Wyre Forest, however, it is possible to maintain some of each habitat.

The best example of a scrub habitat within the forest is that growing on the banks of the old railway track: being in linear form it is easy to split up into sections and manage on rotation. By cutting at different times, a complete range of age structures can be achieved, so that at any one time there is at least one area of each scrubland age group, up to a maximum of about 20 years old. Being of no commercial value, the work of cutting out the bushes must usually be done by volunteers.

Other scrub may be managed in a way that keeps the particular area in a static age class. This is done by removing all bushes except those in the age or size group required. Hedgerows in the reserve, which belong to the scrub group, are managed by being 'laid' in the traditional way; this too is done on a rotational basis. It is a skilled and time-consuming job but produces a worthwhile result. Areas of heather or gorse, if they need to be cut or removed, are treated with a tractor and rear mounted 'swipe'. This, a circular-motion mower using either blades or chains as the cutting edge, handles quite large stems.

Above: An adder flattened out on an old tree stump. This snake is not dangerous unless it is disturbed. People use Wyre Forest extensively and generally do so with consideration for the peace and wildness –and wildlife–they come to find. Ramblers, riders, photographers and naturalists visit regularly. There is even a special 'horseshoe trail', provided by the Forestry Commission, where people can ride (for a fee) over many miles of special tracks.

Below: Mature scrub on the banks of Wyre Forest's old railway track.

Meadows It is difficult to imagine the small scattered meadows of Wyre Forest as part of the forest habitat, but after existing for hundreds of years they are an extremely valuable part of the woodland mosaic. Many species of butterfly need the woodland violet on which to lay their eggs, and the flowers which grow in the old meadows also provide a source of nectar for the adults. The large mounds or 'tumps' of the meadow ant, too, are a common feature of these small fields, and provide a valuable part of the diet of such birds as the green woodpecker. Combined with the meadows there are orchards, now becoming derelict, with old, gnarled or fallen trees, usually full of holes and crannies which are useful for wildlife. These fruit trees are usually the now rare old varieties of cider apple or perry pear, which are replaced wherever possible.

The meadows would soon form into scrub if they were not managed. Management is done in two of the oldest and most traditional ways known–grazing with cattle and cutting for hay. The cattle could be a problem because of the remoteness of some of the small fields, but fortunately there is a farmer quite near who is willing to drive his animals through the forest. They are removed in the spring when

some of the meadow blooms appear–cowslips and green-winged orchids in particular. The adder's-tongue fern can also be found in spring, while the meadow saffron blooms in the autumn. After the hay has been cut in the summer, the cattle return. The hay cutting prevents the build-up of dead litter just above ground level and encourages the meadow flora, as does the fact that no chemical fertilisers are used.

Some of the more remote fields, however, are inaccessible and so cannot be treated in this way. They are cut with a mower and then raked. Horse grazing, when carried out sporadically, can provide an alternative to the better methods, but if too heavy or prolonged may cause damage. One or two areas in the forest display a wealth of blooms–betony, meadowsweet, knapweed, trefoils, marsh thistle and many others–as a result of light grazing by one or two horses.

The ponds One feature not met with often in the forest is ponds or areas of static water. A number of streams run through the steep-sided valleys, however, and most of the few ponds in Wyre Forest have been made by erecting a dam across such a valley. One pool created in this way holds a number of fishes, including roach, perch and carp.

The streams themselves require little looking after, but the trees that grow alongside are managed. One of the most common stream-side trees is the alder, which provides a home for such tree-boring insects as the rare alder wood wasp. This insect requires quite thin stems of alder in which to lay its eggs–coppicing of the trees provides a flush of new growth that meets this requirement.

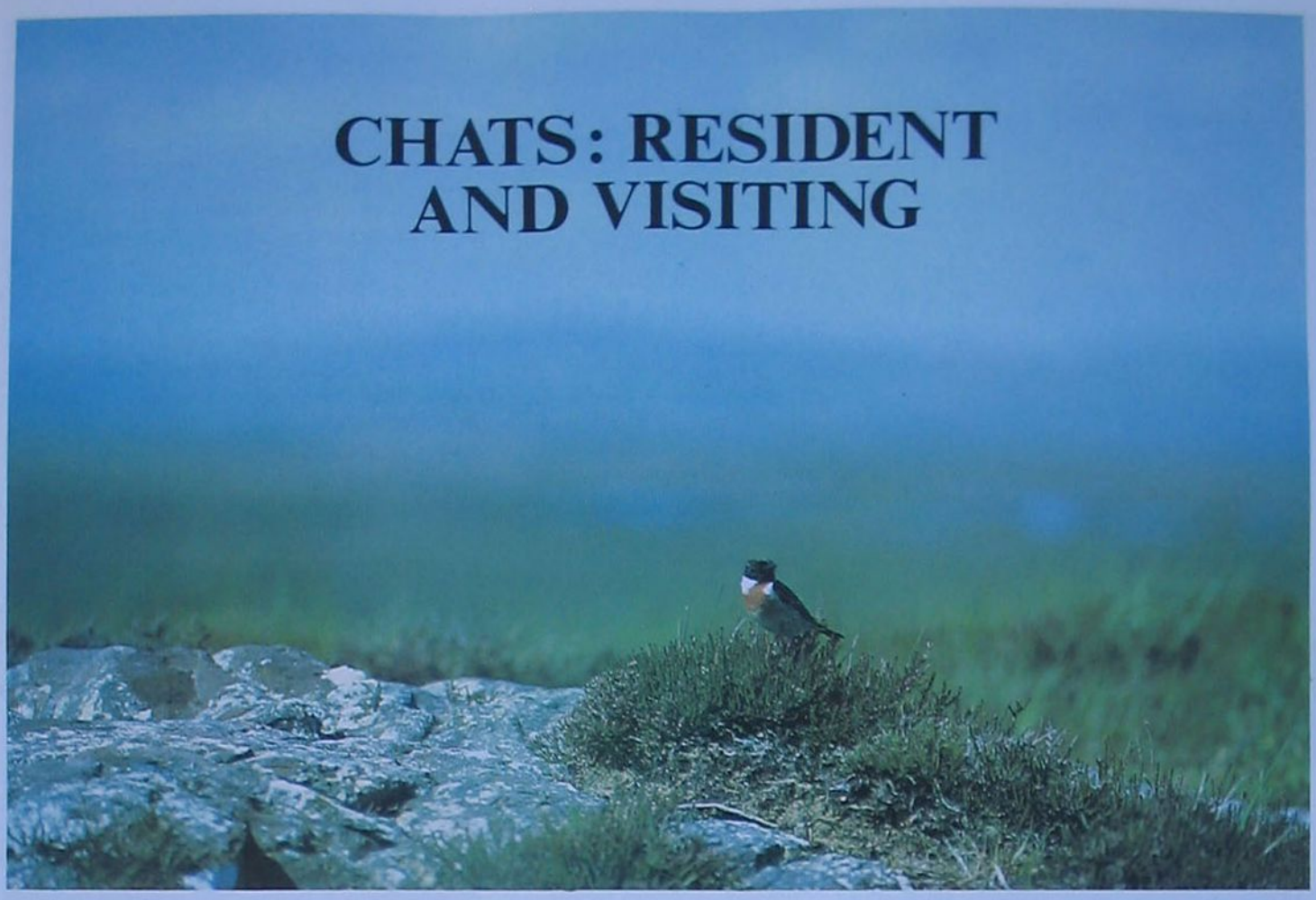
Above: Oak tree felling in the forest. The larger trees will be converted into planks or stakes–an economical return for the labour of growing and felling. Thinning lets light into the forest and encourages a diverse ground layer of plants.

Right: Meadow saffron or autumn crocus–a species that blooms in Wyre's meadows in autumn.

This does not mean that long stretches of alder are removed; instead only a few odd trees are cut.

If too many trees were removed more light would fall on the water and could upset the ecology of the streams, especially the larger ones. As it bubbles over rocks and stones through its mainly sheltered tunnel of trees, the temperature is kept low, and much oxygen is thus dissolved. This provides just the right conditions for many aquatic species–mayflies and caddisflies and their larvae, and fishes such as trout, bullhead, loach and lamprey. Crayfish are common and provide food for a pest species which has moved into the area recently, the mink. This mammal is kept down to an acceptable level by trapping. This procedure is necessary since the mink's numbers could rise to pest proportions, to the detriment of other wildlife in the forest.

CHATS: RESIDENT AND VISITING



Chats are delightfully extrovert in their behaviour, posing obligingly in full view while they sing from the top of a bush or tuft of grass. Our two species are the stonechat, which is a resident bird, and the whinchat, a summer visitor.

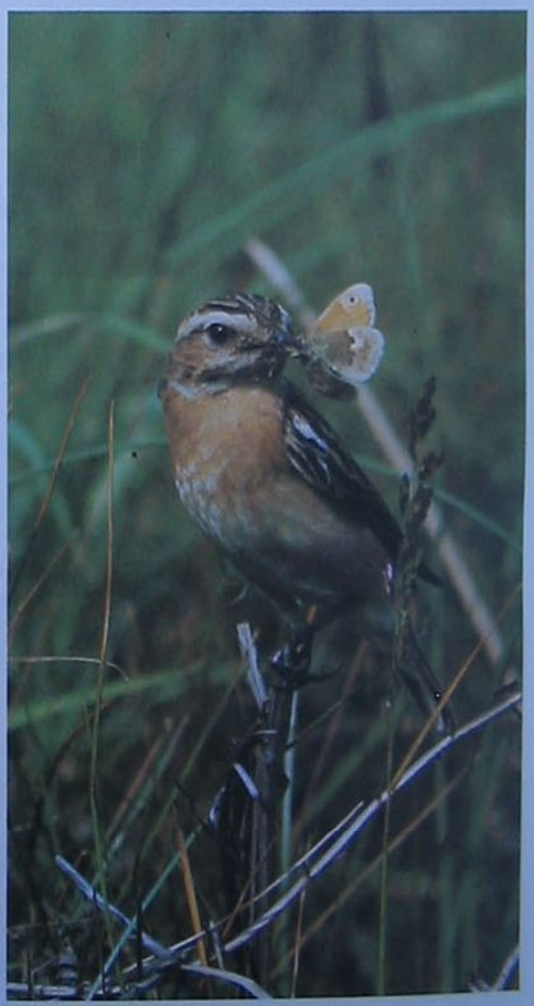
Above: A male stonechat perches on a prominent tuft of grass to sing and survey his territory. This scene is in county Galway in the west of Ireland, where the climate is a little milder than elsewhere. The stonechat's combination of a sedentary existence and demonstrative habits makes it an easy bird to observe. Ornithologists make regular observations of stonechats in chosen locations, marking them with tiny leg rings of varying colours so that each bird can be individually recognised. In this way they have followed the nesting progress of particular birds through the summer and from year to year.

Opposite right: A male whinchat, with a freshly caught small heath butterfly.

Both the stonechat and the whinchat are plump, colourful, upstanding birds, characteristic of open habitats with few trees. Both species are small, measuring only 13cm (5in) from beak to tail. Their English names are for the most part appropriate, since their alarm calls sound just like two pebbles being knocked together–hence 'chat' in imitation of the sound. Whin is another name for gorse, so you might expect the whinchat to be more common in gorse than the stonechat–but this is not the case.

Easy to recognise Both stonechats and whinchats are easy to identify. The male stonechat is an elegant bird, with a black or dark brown back, head and throat, highlighted by a pure white, though incomplete, collar. His chest is conspicuously reddish, fading to white on the belly, and when he flies, or as he flicks his wings while perched, you see white marks on the wings and a pale rump. Females and young birds are similar but much less striking, being more brown than black and having relatively little white.

The male whinchat is also elegant. He has



a broad and conspicuous white eyestripe, blackish crown and cheeks and a richly chequered and speckled back. His chest is a beautiful buff colour – not reddish like that of a stonechat. Flying whinchats show more white on the wings than stonechats, and white at the base of the tail on either side.

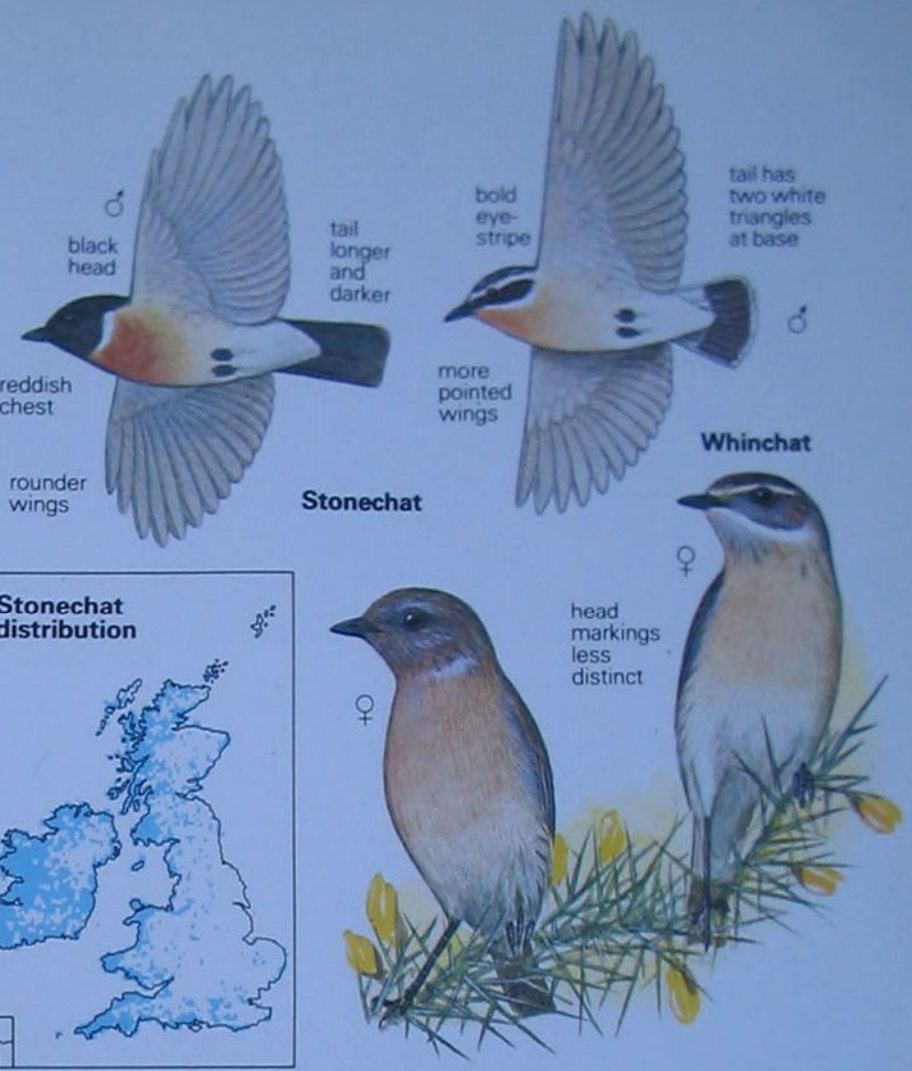
Two important differences between the two chats affect their behaviour, breeding biology and distributions. First, whereas stonechats are mainly sedentary, whinchats are migrants. Secondly, the two species choose slightly different habitats.

Staying through winter The stonechat is a resident species in Britain and Ireland, even though it is difficult for such a small, insect-eating bird to keep warm and well fed in winter. In the past, hard winters have spelt near disaster for British stonechats, with local populations being wiped out on a number of occasions. The coastal areas of south and west Britain and Ireland have the mildest winters in these islands, and consequently that is where stonechats are most numerous. After a particularly bad winter, few can be found in any other areas. Only after a run of mild winters do they spread north and east.

Stonechat habitat Ideal country for stonechats consists of open, fairly close-cropped grassland (for feeding) with scattered gorse and bramble bushes (for nesting). Bracken or heather is often present, but uninterrupted moorland or scrub are of little use to the birds. Such habitat is characteristic of coastal headlands and valleys of the south and west, where sheep, rabbits and the wind keep the grass short and where conditions are unsuitable for arable farming. Inland, this habitat is found on heaths, commons and vacant areas such as railway cuttings.

At the turn of the century stonechats were common in every county of Britain, but many counties have now been deserted by them. This long-term reduction in the population is mainly due to the destruction of their habitat. Curiously, neglect of land is sometimes as serious for the stonechat as modern agriculture since, unless traditional farming methods are maintained – including sheep grazing and periodic controlled burning of gorse – heathland quickly changes to scrub and then woodland. Because of the spread of myxomatosis in recent decades, rabbits have become much less numerous and many areas have become overgrown as a result.

Whinchat habitat Whinchats seem to make use of a wider variety of habitats than stonechats, but their numbers have also decreased this century. Rough, tussocky grassland with some bushes is probably most suitable, but they seem more tolerant of long grass and moorland and frequent, for example, lowland marshes, scrub, arable land and upland pastures more often than stonechats. Their tolerance of, or even preference for, uplands is clearly reflected in their British distribution: the most dense populations are in Wales,



Left: A male whinchat with its insect prey. Since the habitat and food requirements of whinchats and stonechats overlap, competition is fierce.

Stonechat (*Saxicola torquata*). Resident in heathland and open lowland landscapes. 13cm (5in).

Whinchat (*Saxicola rubetra*). Summer visitor, breeding in heathland, on higher ground and in young conifer plantations. Length 13cm (5in).

northern England and Scotland.

Stonechat breeding Stonechats hold territories all the year round and the boundaries – marked by such features as streams, fences or boulders – often remain the same over several generations. In spring and summer the males defend the territories from other stonechats by singing – a tuneful dunnock-like jingle – from a prominent perch or in a high, hovering song flight.

While some stonechats may keep the same mate for life, there seems to be a tendency for considerable reorganisation each spring. This is well illustrated by a study in Jersey in 1955, in which eight pairs of stonechats were under close observation. All the birds had apparently been quite content with their mates throughout the winter months. Then, within four days at the very end of March, two males and one female found new mates from outside the study area, two adjacent pairs exchanged mates, one male found a second mate, one pair changed its territory and only one pair remained unchanged!

Above: The nest of a whinchat. This is normally extremely well hidden – here the sheltering layer of grass and foliage has been removed temporarily for photographing. While the female incubates, the male stands by looking out for danger, ready to call the alarm if necessary. When leaving the nest – either because of an intruder or in order to feed – the female does so with great caution. On the 13th or 14th day the chicks hatch, their greyish-white down drying to provide insulation within a few hours. Both parents feed the young. The usual technique is to find a perch and watch the ground for insects.

The nest is made inside a clump of grass or in the shelter of a bush, and up to six eggs are laid, one a day. After they have hatched, the chicks are fed on such insects as moths, butterflies and small flies, as well as on larvae.

Whinchat breeding The breeding season of the whinchat is quite different. Most whinchats lay their first clutch in May – a full two months later than most stonechats. Indeed, whinchats usually arrive in this country in late April or early May, just as the stonechat broods are leaving their nests. Most stonechats raise two or three broods, the last clutch of eggs being laid in July or early August, whereas whinchats can raise only one or two broods, the second clutch being laid by mid-July.

When they first arrive at their breeding sites, male whinchats stake out territories as soon as possible, so that when the females arrive a few days later, breeding can start immediately. Their song is very variable and often includes mimicry of neighbouring bird species. Like the stonechat's, it is delivered from an exposed perch and initially there is considerable rivalry between males.

Whinchats lay, on average, one more egg than stonechats, but this does not make up for the smaller number of broods. In addition, studies have shown that whinchats' nests are more vulnerable to predation and other losses than those of stonechats, and it has been calculated that stonechats may fledge almost three times as many young in a season as whinchats. As a result of this you might expect stonechats to be much the commoner of the two. However, the winter survival of whinchats is comparatively high and this restores the balance between these attractive and closely related species.

Right: A female stonechat with four chicks. The nest is well concealed amid the grass: often it is placed inside a clump of grass, with a tunnel or shaft up to 25cm (10in) long for access. Sometimes the nest is built inside a bush. Fledging takes about two weeks: it can be delayed by adverse weather or precipitated by the appearance of a predator near the nest. After this period the chicks can fly, though their wings are not yet fully grown. Both parents remain in attendance for about 5 days; the male then continues to feed the brood while the female starts building a second nest. In normal conditions the second clutch is complete only 46 days after the first.

THE UNIQUE FLORA OF CONNEMARA

On the west coast of Ireland lies a small region of County Galway called Connemara, an area justly famed for its unique collection of plants – some of them are extremely rare and a few are to be found nowhere else in the British Isles.

Below: The northern part of Connemara is dominated by the Twelve Bens, a series of peaks, the tallest of which – Benbaun – is 730m (2395ft) above sea level. Much of the surrounding lowland is moorland studded with outcrops of rock. In the summer these moors are lit up with a brilliant display of flowers – here the yellow of dwarf gorse (*Ulex gallii*) intermingling with the purple spikes of bell heather (*Erica cinerea*), a common species in the area.

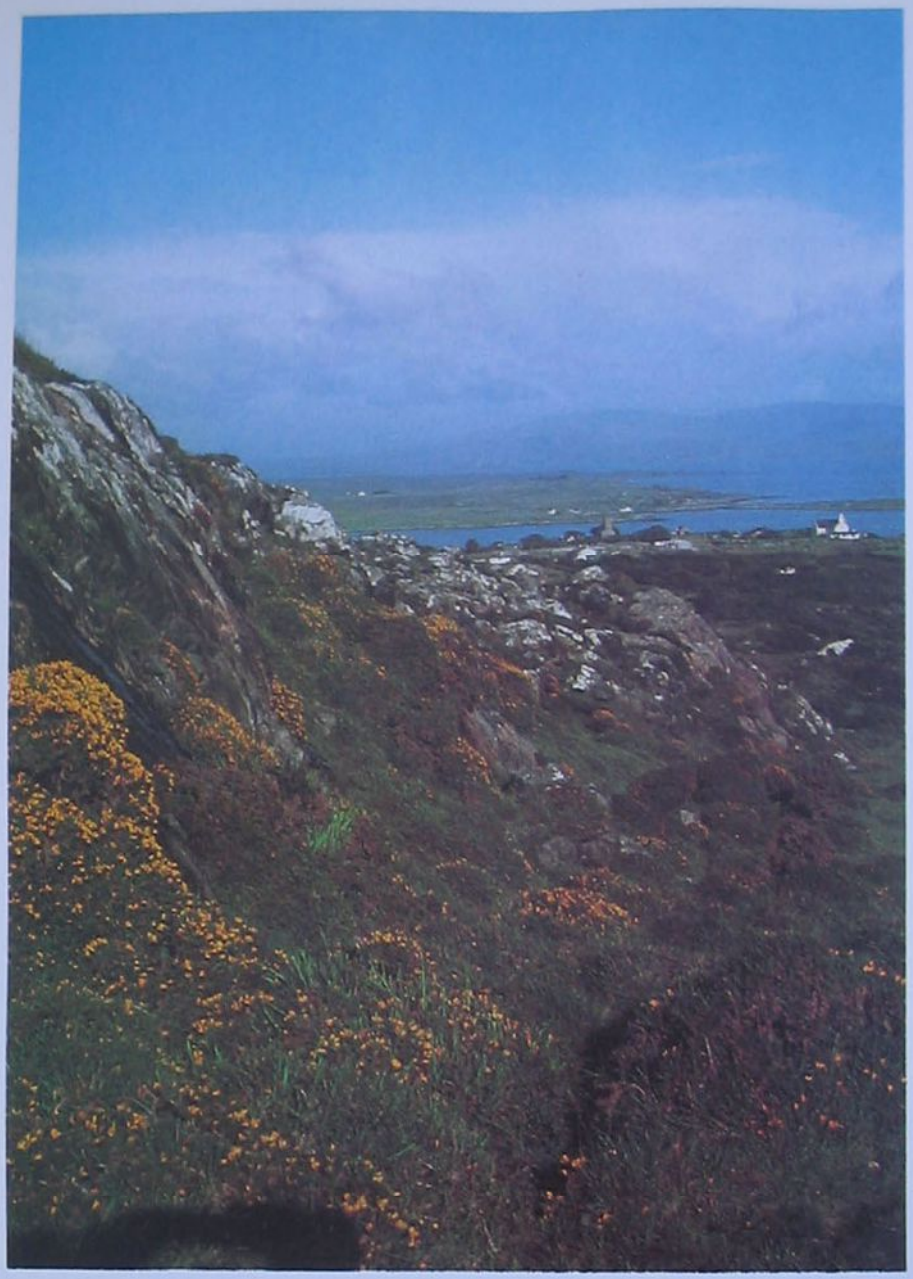
Connemara is the name given to the western-most part of County Galway on the west coast of Ireland. It is a botanical paradise, the home of plants from as far apart as the Arctic region and Spain. The climate is mild; the prevailing westerly winds are laden with moisture and the rainfall is high – as much as 2500mm (100in) a year in the mountains. This is about four times the rainfall in parts of eastern England, which is the driest region of the British Isles.

Mountains and moorland Much of the northern part of Connemara is occupied by the pyramidal peaks of the Twelve Bens. These mountains are composed of schists and quartzite, and rise to more than 600m (2000ft) above sea level. Their steep slopes, glistening with water, provide a spectacular backcloth to the undulating moorlands of southern Connemara.

The Bens have an interesting Alpine flora, although none of the species is restricted to the area. Purple saxifrage can be found on the highest peaks, along with Alpine meadow-rue. In sheltered places lower down, other saxifrages and a number of uncommon ferns, such as the holly fern, grow.

Most of the low-lying southern part of Connemara is covered with a blanket of peat, with outcrops of schist and quartzite. Hundreds of small loughs are scattered throughout the area. The moorlands themselves are devoid of trees and seem desolate, but in sheltered valleys oak woodland survives. In a few places forestry plantations are now established, but only where there is shelter. The moors are dominated by heathers, including ling, sedges and moor-grasses, such as purple moor-grass. In the dampest hollows are 'quaking' bogs, their surfaces consisting of little more than thin rafts of sphagnum moss.

Heaths and heathers Connemara is unsurpassed in the British Isles for its heaths and heathers. In March on Errisbeg Mountain (which lies west of the village of Roundstone) the Irish heath comes into bloom. This plant has pale pink flowers and grows in the beds of streams on the western side of the mountain. This colony is the most southern in Ireland,



for the main habitat of the Irish heath is in County Mayo, just to the north. It is not native to Britain, however, the nearest European colonies being in northern Spain.

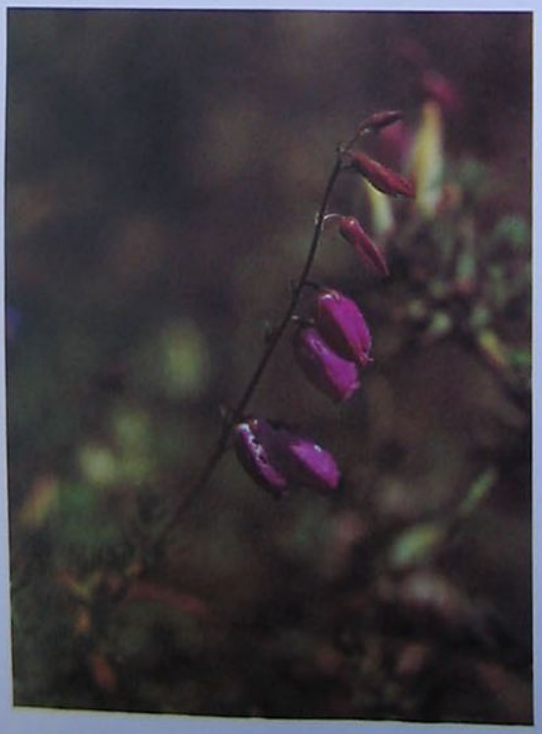
In July and August, Mackay's heath comes into blossom, carpeting the ground between Roundstone and Clifden in the south-west. This heath is similar to the cross-leaved heath – which is found in both Britain and Ireland – except that it has clear pink flowers and a hairless ovary. Mackay's heath does not grow in Britain and its only other location is in northern Spain. Irish specimens do not set seed but reproduce vegetatively, even small fragments of root being capable of regenerating to produce new plants.

Despite its sterility, Mackay's heath can hybridise with the cross-leaved heath, and the hybrid is abundant in areas where both parents grow. Strangely, however, the two species do not hybridise in Spain.

Connemara is the only region in Ireland to boast the Dorset heath, a plant found locally in parts of southern England. About six plants are known in Connemara, all in one small area, which makes this one of Ireland's rarest native species.

The gem of Connemara's flora, however, is undoubtedly St Dabeoc's heath. This plant has elegant urn-shaped flowers, which are bright purple and up to 1.5cm ($\frac{5}{8}$in) long – much larger than those of other native heaths. Very occasionally, albino plants with pure white flowers are found, and a form with reddish-pink flowers is also known but extremely rare.

New discoveries The unique flora of Connemara has long drawn botanists and plant collectors. For example, the Welsh antiquarian, Edward Lhuyd, visited the area in 1700 and collected both the Irish heath and St Dabeoc's heath. Yet, despite almost three centuries of



Above: A view of the village of Roundstone from Errisbeg Mountain. The yellow flowers in the foreground are of dwarf gorse.

Right: Errisbeg Mountain is the only site in Connemara for the Irish heath. This is the tallest of the heaths, growing to a height of 2m (6ft). It flowers in March, producing long spikes of pale pink, tubular blooms with protruding reddish anthers.

Left: The finest of Connemara's many species of heath is St Dabeoc's heath (*Daboecia cantabrica*), a summer-flowering plant producing large pale purple – occasionally white or reddish-pink – flowers.

botanical exploration in Connemara, new plants are still sometimes discovered there. In 1965, for instance, the forked spleenwort, a small fern known from a few places in western Britain, was discovered on Errisbeg Mountain, where it grows in the cracks of one massive boulder—occurring nowhere else in Ireland. The following year, slender cotton-grass, which is well known in the bogs of southern England, was discovered in Connemara. It has since been found elsewhere in Ireland.

Strangest of all was the discovery near Carna, in 1971, of a rush with grass-like leaves (British rushes have a distinctly different leaf structure from that of grasses). At first botanists were puzzled, but the plant was soon identified as *Juncus planifolius*, a native of South America and Australasia. It is certainly not native to the area but was introduced accidentally by man. It thrives in roadside ditches in Connemara and is spreading.

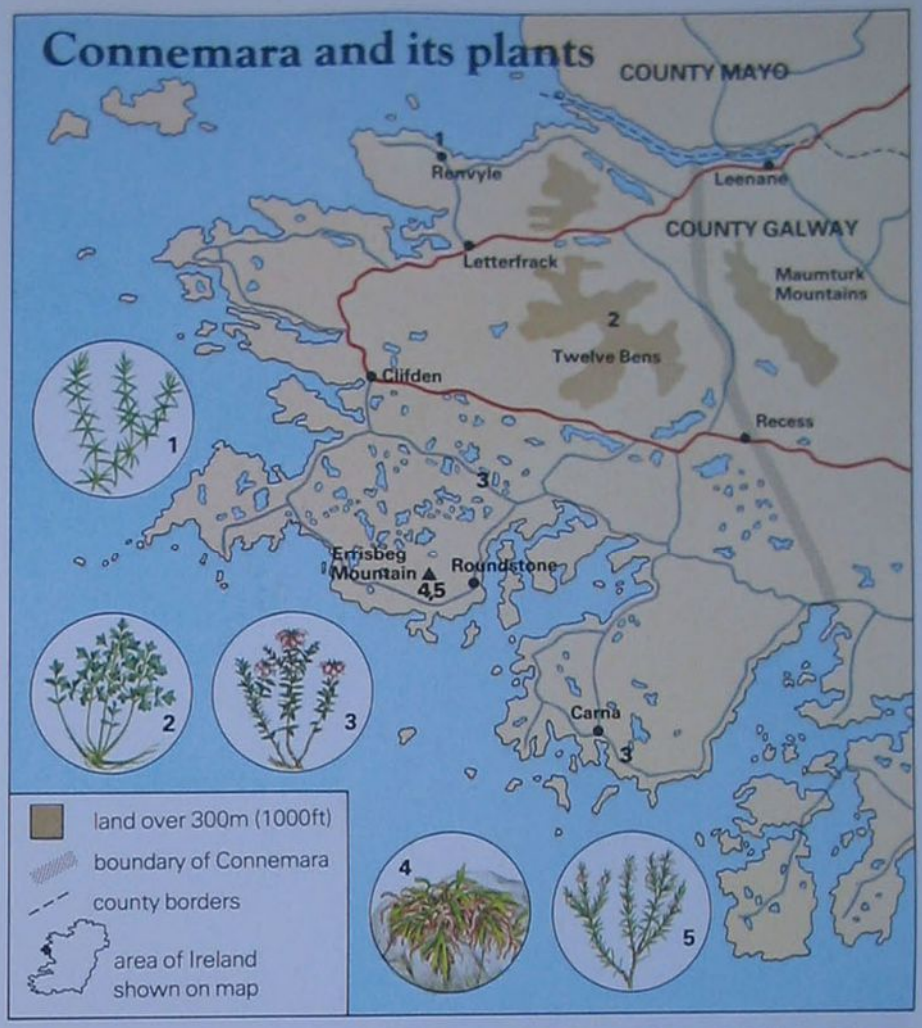
This species is one of a small number from the Southern Hemisphere that enjoy the equable climate of Connemara and have become naturalised there. The New Zealand flax is another. It forms huge clumps of sword-like leaves and is widely planted as a windbreak. Fuchsia grows in the hedgerows of Connemara, flowering profusely from May until Christmas. In its native Chile, the scarlet and purple hanging blossoms are pollinated by hummingbirds, but in Ireland this role is eagerly performed by bees.

Lough plants The Connemara loughs contain many fascinating plants, some of which are found in few other parts of the British Isles. One such is the pipewort, which grows either submerged or in damp peaty soil at the edges of loughs. Its grass-like leaves are a transparent pale green, and in summer the flower heads emerge above water looking rather like large hat-pins. Each head is formed from numerous tiny bluish-white flowers. It is native to eastern North America and, in Europe, is restricted to western Ireland and the isles of Skye and Coll.

One Connemara lough, near Renvyle, is the only site in the British Isles for *Hydrilla verticillata*, a pondweed rather like Canadian pondweed, except that it has narrower leaves which are usually arranged in whorls of four.

Coastal plants The coastal dunes provide a quite different habitat from other parts of Connemara. The soil contains lime, so lime-loving species abound, some of which are common in the Burren, 75km (45 miles) south-east across Galway Bay.

The spring gentian and the pyramidal bugle are among the flowers found on stable dunes, and a form of sorrel with hairy leaf stalks and veins found there is considered by some botanists to be a distinct species. Babington's leek, a species of wild onion, inhabits these coastal sands. It may be a relict of ancient Celtic agriculture, brought to Ireland from Spain thousands of years ago.



Above: Some of the more localised plants of Connemara: (**1**) *Hydrilla verticillata*; (**2**) Alpine meadow-rue (*Thalictrum alpinum*); (**3**) Mackay's heath (*Erica mackaiana*); (**4**) forked spleenwort (*Asplenium septentrionale*); (**5**) Irish heath (*E. erigena*).

Right: Mountain avens—a Burren outlier—is found on one mountain in Connemara, near Recess.

Below: The rare white-flowered St Dabeoc's heath.

EXOTIC SPIDER SPECIES

Some of the more unusual spider families are represented in Britain by only one species. These spiders are spectacular in appearance and have some extraordinary habits.

Above: The female nursery web spider (*Pisaura mirabilis*) cares for her eggs and young in a most unusual way. After mating she produces a large sac containing about 100 eggs which she carries with her for the next three weeks. She straddles this burden (seen clearly in the picture), holding it with her fangs and binding it to her spinnerets with silk. When the eggs are ready to hatch she attaches the sac to grass blades and weaves a nursery tent around it.

Twenty-seven families of spiders exist in Britain, the majority of which are represented by several species. There are, however, a few families which have only one or two species in this country. These spiders, relatively easy to distinguish, are remarkably attractive and endowed with some fascinating behavioural patterns.

Tarantula's distant relative The purse-web spider *Atypus affinis*, one of our most unusual spider species, is the sole British representative of the sub-order Mygalomorphae, which includes tarantulas and trap-door spiders.

The female is brown with a greenish hue and at 12mm (½in), is larger than the 9mm (⅓in) long male, which is darker in colour. They are found in areas of light soil in southern England – usually downland and heathland – and occur in colonies.

The most striking features of the purse-web spider are its home and its method of catching prey. It lives in a long silken tube constructed partly below and partly above ground. The aerial section, which leads into the subterranean section, lies among vegetation and may easily be mistaken for a projecting root. When an insect – a fly or a beetle – crawls over the tube the spider thrusts its fangs through the walls and pulls the victim inside. The walls are later repaired with silk.

The spider's downward-striking fangs are not only used for catching prey. They also serve a purpose when the spider is constructing its tube. The burrow and the aerial part are both built at the same time – the spider carrying soil particles from the burrow with its mouth-parts and, with cement from the mouth, laying them between successive layers of silk to form the aerial tube.

Death after mating Only the male leaves the tube, when he goes in search of a partner in winter. On finding a female's tube he vibrates his palps and legs – signals which are essential to avoid attack from his prospective partner; if he receives no reply he cuts a hole in the tube and enters. Unfortunately these can be the last few moments of his life for the male often dies after mating – either naturally, or by being murdered by his ruthless partner.

The female lays between 100 and 150 eggs in a silken cocoon the following summer. They hatch after about a month and then remain quietly in the cocoon until spring (about 8 months), when they emerge and scatter to build their own tubes.

Ladybird spider If the purse-web spider is our most unusual species, the ladybird spider is our handsomest. The adult male (9mm/⅓in long) has a red abdomen with six black spots, each surrounded by a white ring, while the rest of the body is black and white; the female (12mm/½in long) and immature male are velvety black all over.

This species was feared to be extinct, since it had not been seen for over 75 years, but happily it was rediscovered a few years ago in Dorset.

Like the purse-web spider it inhabits a silk-lined burrow which is excavated in soft soil or sand and opens out into a complex system of criss-crossing threads designed to ensnare prey. The remains of large beetles around the mouth of the burrow attest to the web's effectiveness.

Mating occurs in spring and soon after the female lays about 80 yellow eggs, which she covers with silk and camouflages with food remnants or plant material. She stores the egg cocoon in her burrow at night but brings it up to the aerial section in the daytime for greater warmth. The young spiderlings hatch in June, and when the mother dies in July they eat her body.

Banana spider relative The only British member of the family Sparassidae (which includes the banana spiders of the tropics), *Micrommata roseum*, vies with the ladybird spider as our most attractive species. The female (12mm/½in long) is bright emerald green while the more spectacular male (8mm/¼in long) is vivid yellow with red and green stripes on the abdomen. This is a rare species but may be seen in large numbers where clumps of purple moor-grass and young oaks grow in woodland rides in southern England.

Micrommata roseum does not construct a web. Instead it sits head downwards in the grass, ready to spring on passing insects. Mating begins when the male leaps on top of the female and seizes her with his fangs – there are no courtship preliminaries. After six to eight hours the male departs as speedily as he arrived, for if he stays too long his life is in danger.

The aggressive female lays about 30 eggs in July and encloses them within three or four oak leaves fastened together with silk threads. She guards them until the young have hatched and departed.

Silken crèche The nursery web spider is a brownish-grey colour with a white stripe down the centre of its cephalothorax. It is extremely common and is found among tall grass and in hedgerows almost everywhere in summer. Nevertheless, it is worth describing for its unusual habits, notably the courtship ritual.

Such is the greed of the female that the male is likely to find himself eaten if he does not placate her. He therefore catches a fly and presents it to his partner before mating, so that she can concentrate her hunger on the gift instead of on him. While her fangs are sunk deep in the food parcel the male mates and then hastily departs – sometimes taking the fly with him.

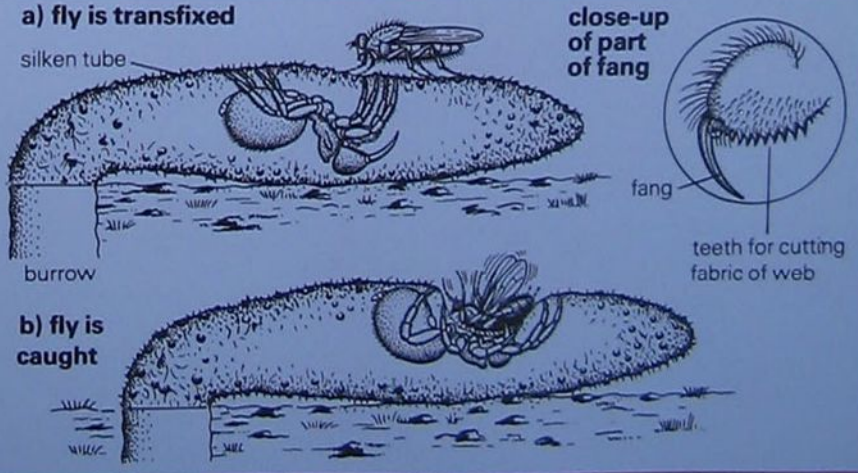
In June the female produces a large egg sac containing about 100 eggs, and carries it with her until the contents are ready to hatch. At this stage she attaches the sac to blades of grass and weaves a 'nursery tent' around it so that when the small spiderlings hatch they are protected by a silken structure.

Above: The ladybird spider (*Eresus niger*) is undoubtedly our most handsome rarity, with its red abdomen covered in black spots. It is an extremely scarce species and was at one time feared extinct, although it has recently been rediscovered in Dorset. The young spiderlings have an unpleasant nature – they eat their mother when she dies, about a month after they have hatched.

Right: *Micrommata roseum*, another rare spider, has no web. Instead it catches its prey by waiting on a blade of grass head downwards (as in the picture) and leaping on any unsuspecting victim that happens to pass by.

Spider booby-trap

The purse-web spider *Atypus affinis* lives in a long silken tube which is divided into two sections with no entrance or exit. The burrow extends about 20cm (8in) into the soil and opens into the aerial section which is approximately 5cm (2in) long. This lies among vegetation or points up a sloping bank and may easily be mistaken for a projecting root. When an insect alights on the tube the spider uses its fangs to transfix and then seize the prey. It then cuts into the fabric of the burrow with the sharp teeth on the basal segment of its fangs and pulls the victim inside.



Funnel-web Another common but unusual spider is *Agelena labyrinthica*, a member of the family Agelenidae. You are most likely to find this species beside its funnel-shaped web, which is seen among gorse, heather and grass in July and August.

The web comprises a silk sheet, made of numerous 'trip wires', which narrows into a funnel at the entrance, where the spider usually lurks. If you watch and wait quietly you may see *A. labyrinthica* dart out of its web when an insect blunders into the silk trap. It then delivers a series of bites to weaken the victim before dragging it in to the retreat.

A. labyrinthica mates in July; when mating, the male, which is smaller than the female, tweaks her web and, if she is receptive, he hauls her to the position of his choice.

The female lays approximately 150 eggs in an elaborate chamber fixed to the nearby vegetation and stays with her eggs and young until she finally dies.

Above: A pair of *Agelena labyrinthica* spiders mating in the female's lair. Prior to this the male arrives at the female's funnel-shaped web and tweaks it.

Right: The female *Argiope bruennichi*, a newcomer from the Mediterranean, is particularly conspicuous as she sits upside-down at the hub of her web.

Opposite page: A female nursery-web spider guarding her young spiderlings.

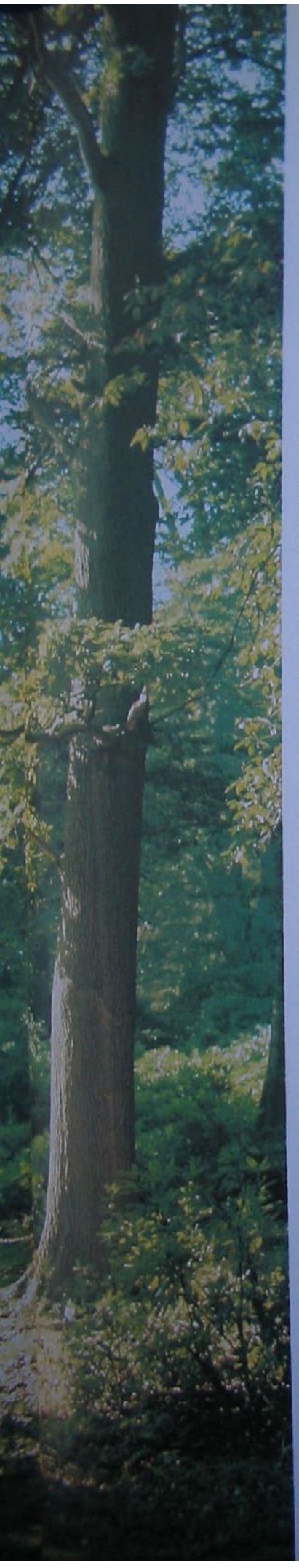
Below: Silk 'fishing lines' radiate from the tunnel-home of *Segestria florentina*, communicating vibrations of passing prey to the spider.

Mediterranean species Two of our rarer spiders are from the Mediterranean and have only recently colonized parts of this country. *Argiope bruennichi* is a builder of orb-webs which are situated close to the ground to catch grasshoppers and crickets. The female (15mm/⅔in long), with her silvery cephalothorax and bright yellow black-barred abdomen, is often seen sitting upside down at the hub of her web.

Although the female is found throughout the summer and autumn, the much smaller male is active for only a couple of weeks in July. His life is a dangerous one, for when mating he often finds that his partner tries to bind him up in silken thread. A hasty retreat is therefore required but may often result in the loss of a leg or two.

The other Continental migrant, *Segestria florentina*, is a large, black, aggressive 'tube-web' spider found in southern ports. It constructs its web in holes in brickwork and tree-bark crevices, and lays down 'fishing lines' of silk which radiate from the opening and communicate the vibrations of passing insects to the spider. When alerted, the spider rushes out of the hole to intercept and catch the prey.

Recent experiments have revealed that this species has an unpleasant bite which, if experienced by a human being, leaves two visible and widely spaced holes where the fangs pierced the skin.



SUMMER: SEASON OF REPLENISHMENT

Summer, with its long hot days and short nights, sees the countryside buzzing with life. Many species are raising a second brood of young, taking advantage of the season's abundance of food and protective luxuriant growth. As autumn nears, the days become sultry, bird song dies and only insects are heard.

No season is hailed with more pageantry and merriment than the birth of summer on May 1st, for summer is above all the season of replenishment. May-day rituals, of great antiquity, reflect a bygone time when our own prosperity and survival were more intimately entwined with the quickening of nature.

The maypole symbolises many things, but none more than the hub around which the seasons revolve. For plants and animals, this hub, in turn, is the sun which has been progressing northwards with the unwinding of spring. The movement heralds a weakening of the vigorous storm track which has dominated the weather pattern in winter and spring. As April passes into May, high pressure steadily asserts itself over the Azores in the mid-Atlantic, wafting warm, clear weather to the shores of Europe, and the troublesome low pressure region centred over Iceland begins to flag, enhancing the growing stability of the Azores high.

With the welcome improvement in the weather, May sees a swift conclusion to April's tentative unfolding of woodland foliage. In many places the pinnate leaves of the ash are the last to appear, in early May. The sudden opulence of deciduous woodland tends to obscure the quiet stirrings of the conifers. Because they are adapted to the fleeting summers of northern climates, spruces and pines concentrate their growth between May and July, most dramatically in the eruption of a candle-like spire from the topmost bud. With the expansion of a number of side shoots from the crown, the spruce thus adds, like mounting scaffolding, a new whorl of branches every year, building with conical precision on top of the layers below.

As the tree community spreads its canopy, a deep shade engulfs the woodland floor, and the flush of flowers which thrived in the spring sunlight filtering through the bare branches begins to wane. A second generation of shade-tolerant herbage flourishes, dominated in many English woods by a green sea of dog's-mercury. The new emergent flowers, like woundwort and bugle, have a deceptive lustre in this muted light, none more so than the carpets of bluebells which attract man and other animals alike by their heady fragrance.

High in the mountains a choice variety of alpine flowers nestles close to the ground and between crevices. Species such as roseroot and mountain avens add a dash of colour to the rocky slopes, and colonies of golden yellow globe flowers thrive down in damp gullies. On clifftops and on rocky shores patches of pink thrift and various orchid species blossom. With a rich brew of colour, scent and shape, the summer flowers vie among themselves for the favours of passing insects.

Flowers and insects have had such a long evolution of mutual benefit – the giving of nutritious nectar and pollen in exchange for pollination – that the majority of summer flowers are oases, purpose-built to satisfy their guests. Some, such as roses and poppies, produce only pollen which is sought by beetles and hoverflies, as well as by the better-known bees and butterflies. Many, such as the orchids, fumitories, and flowers of the pea family, are so constructed that bees, in seeking the nectar source, cannot help but brush against the pollen-bearing stamens as they enter and leave the flowers.

Flowers help bees in various subtle ways to recognise them as targets. In hedgebanks, the spikes of foxgloves and viper's bugloss, for example, are luminous to bees whose vision is finely tuned to their mauves and blues. Similarly, reds and mauves are especially attractive to many butterflies.

Bees and some other insects see ultra-violet light which is invisible to us. Not surprisingly, some flowers have evolved ultra-violet markings which help the insect to home in on the nectar source. The evening primrose, for example, which appears to us a uniform yellow, has a striking ultra-violet patch at the centre which glows to night-flying moths.

Just before dark we may see one of the most typical moths of June and July. Jigging about over the grass, as if on the end of an invisible thread, the male ghost swift moth performs an aerial dance to attract females. Like the fragrant honeysuckle (and for ultimately the same reason – self-perpetuation), it too leaves a telling trail of odour in the night. In this case, however, it is a specific attractant – a pheromone – which the female can follow upwind before mating. Once mated, the female lays her eggs in a somewhat unorthodox manner (compared with other insects).

Most moths lay directly on the foodplant of the caterpillars-to-be, and exercise great care in doing so. The cinnabar moth, for example, seeks ragwort for its black and yellow banded larvae to devour when they hatch. The female ghost swift moth, however, just drops her eggs into the grass as she flies. When they hatch, the caterpillars crawl into the soil to feed on roots.

In the tree-tops, caterpillars of a host of relatively inconspicuous moths have been gorging themselves on the foliage and flowers since the buds burst, and are now ready to pupate in June. Some, such as the green oak tortrix, cocoon themselves in a nearby leaf; others, such as the winter moth caterpillar, lower themselves to the ground on a silken thread. Exceptionally, a large oak may play host to half a million winter moth caterpillars alone, and in such outbreak years the effect of this and other leaf-eaters can be devastating, stripping the tree of its leaves and even sometimes killing it. If you walk through such a wood in early June there is an audible and incessant whisper of frass – the residues of the caterpillars' activities in the canopy – raining down on the woodland floor. Oaks, and other deciduous trees, however, are usually capable of countering such attacks, producing new buds to compensate; as late as July, there may be a resurgence of growth, the so-called Lammas leaves. The new foliage is virtually devoid of caterpillars which, having eaten themselves out of house and home in June, seal their own fate.

These caterpillars which, even in average years, are enormously abundant, are the life-support of most of our woodland birds, and often the resource which regulates their breeding success. Not only do they sustain our resident species, but also a huge immigrant population of warblers. We often suppose that birds breed throughout the summer, but for many the season is relatively short-lived, and over by the end of June when all the caterpillars have pupated and are less accessible. This means that the birds have to start nesting before the caterpillars emerge *en masse* to ensure their young are in the nest at the caterpillar peak.

Most great tits and blue tits, for example, squeeze all their breeding activities into the eight weeks of May and June. Once the young

hatch, the parents' work-load is formidable. A pair of blue tits may transport about 10,000 caterpillars to the nest in 18 days, about the time it takes for the young to fledge. There is much debate about how much impact such an onslaught has on woodland caterpillars, but in the long term the moth populations are as resilient as the mother oak. For the blue tit this onerous hunting schedule would be impossible without the bonus of extended summer daylight. Birds and other animals breed in the summer not only because food is most abundant then but also because there is sufficient time to find it.

Though caterpillar stocks are largely exhausted by the end of June, the peak of flying insects occurs later, and times the breeding effort of some other insectivorous immigrants, notably the spotted flycatcher and the nightjar. Many birds which normally feed from the ground become more adaptable at this time, and we may see such species as starlings and gulls hawking for swarms of flying ants. Indeed, relatively large birds often resort to preying on insects if they are sufficiently numerous or large to warrant the chase. A substantial and clumsy flyer like the cockchafer (or Maybug) then becomes fair game for the rook, the little owl, and even the tawny owl.

The feverish activity of birds–singing, fighting and foraging for food–makes them highly vulnerable to predation in summer. Hole-nesting tits are often discovered by keen-eyed weasels, needing sustenance for their own hungry young. Many fledglings and eggs likewise fall prey to roving foxes and other mammals; even the grass snake marauds nests by scaling trees such as the willow.

By the end of July most birds are moulting their dishevelled breeding plumage. Drake mallards moult in a particularly drastic fashion, dropping all their primary and secondary feathers at once; they take refuge in reed beds and play no part in raising their own offspring. The duck tends them alone, leading her charges to the shallows where frog tadpoles are still easy prey.

In the open countryside, which is starting to brim with ripening seeds and fruits, the change in the tempo of bird life seems somehow almost too sudden and premature. It is signalled by a virtual cessation of song and often July finds the yellowhammer sawing out his lazy notes unchallenged. This is summer's most indulgent time when, with luck, it is too hot for us to do anything except listen to nature's other sounds; by the pond there is the thin clattering of the hunting dragonfly's wings, broom seeds cracking in the sun, and grasshoppers singing down below. It is not quite the sound of the jungle, though the closest we ever get in the British Isles with our only cicada insect species, the rare *Cicadetta montana*.

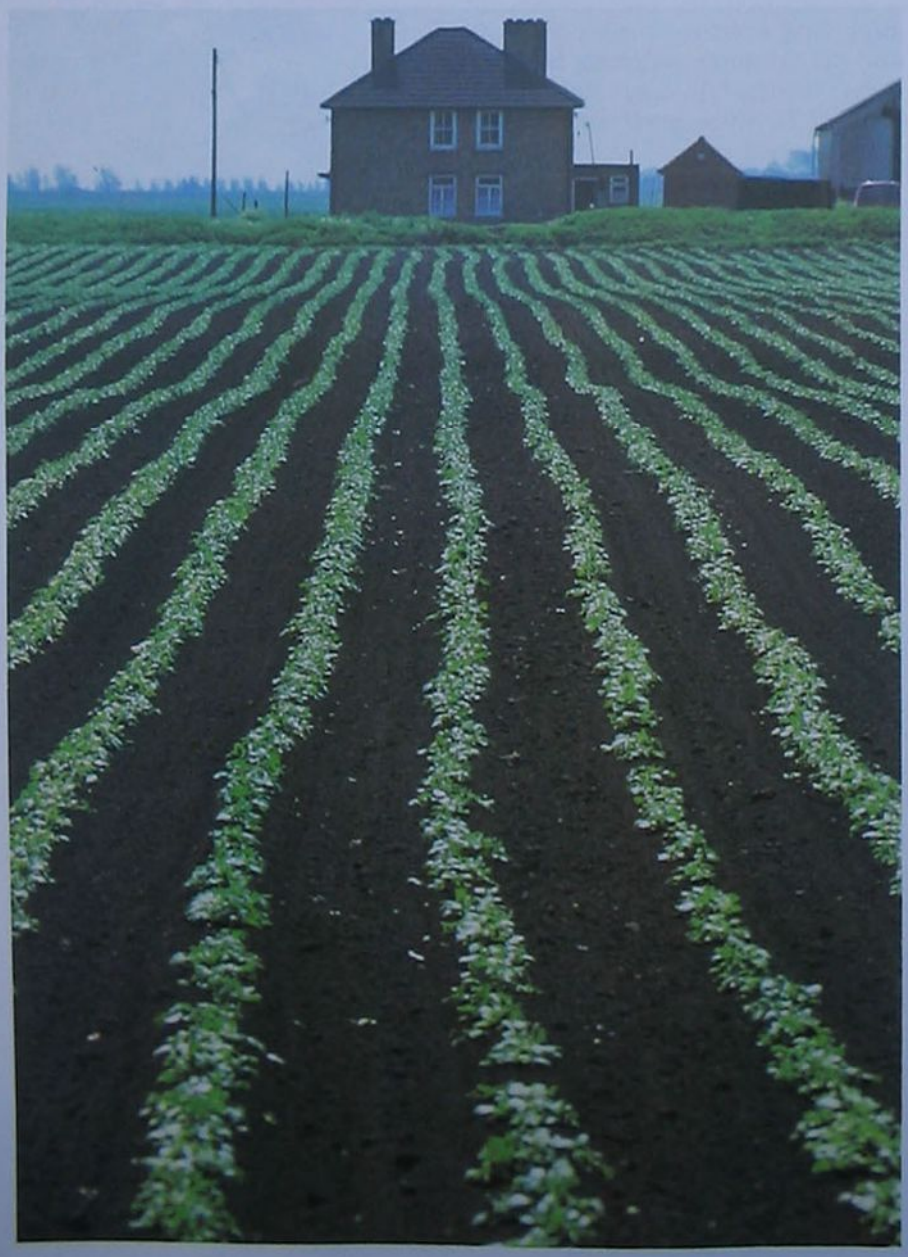
In the wood, the undergrowth has become rank with bracken, nettles and willowherb–too tall to make watching badgers and fox cubs worthwhile any longer, and dense enough to offer good protection to mice, dormice and voles. The first half of August brings the 'dog days' when the brilliant Dog Star Sirius rises and sets with the sun. It is characteristically a time of hot, sultry, weather when warm air towers over the newly harvested stubbles and thunderstorms descend on them. Harvest mice scuttle for safety away from the rain and the combine harvester. Occasionally the heat even becomes uncomfortable for some animals such as lizards which temporarily go underground to 'aestivate' for a while. If we have a prolonged dry spell, earthworms also aestivate deep in the ground to remain moist, well away from the strong sunlight.

It can be a particularly trying time for birds such as rooks, which are dependent on soil invertebrates for food. Many, especially inexperienced young birds, resort then to roadside verges to glean the insect casualties of passing traffic. For an enormous number of others, there are clear signs of the bonanza ahead: the scarlet berries of the rowan ripening early in August and the darkening blackberries have already given the thrushes and blackbirds a foretaste of the season to come.

SOIL: TYPES AND COMPOSITION

The mixture of mineral and organic material that makes up the soil is subject to infinite variation in texture, colour and chemistry. The key factor is the parent rock itself–which may be granite, chalk, sandstone or beds of gravel or clay.

Below: A crop growing on black fen soil in Cambridgeshire. Waterlogged fens, if not too acid, can prove to be extremely fertile when they are drained, the fen peat rapidly breaking down into a rich humus.



Any gardener who has wrestled with intractable clay, hungry structureless sand or the thin, sour soil of heathland is acutely aware of soil type, and of the wisdom of choosing plants with appropriate requirements–rhododendrons on acid, for example, or roses on clay. Beyond the garden gate such soil diversity is reflected in our natural flora–orchids and the pasque flower on lime-rich chalk downland, for instance, and heather and bilberry on acid heath.

What is soil? The fundamental components of soil are rock fragments, clay and broken-down organic matter. The rock fragments are the result of physical erosion by frost, heat, wind and water, all of which crack and splinter the parent rock into smaller and smaller pieces. These may be carried away and deposited elsewhere as gravel, sand or silt, or remain to be broken down further where they lie. A cross-section of undisturbed soil overlying a friable parent rock can show every stage of this fragmentation process, from the fissured rock of the deepest layers to the fine sand of the topsoil.

In addition to the physical weathering, rock is also subject to chemical erosion by rainwater which, in passing through the atmosphere, combines with carbon dioxide to form very weak carbonic acid. This dissolves alkaline minerals such as calcium, and in time completely destroys the structure of calcareous rocks. Acid minerals such as silica are unaffected, and consequently granite, which contains a high proportion of silica, is relatively resistant. Nevertheless, the alkaline components are attacked, and the rock is eventually broken down. The acid silica is liberated as sand, the alkaline elements are dissolved, and the residue is converted, roughly speaking, into clay.

Clogging clay Clay has particular properties which set it apart from other soil minerals. Its particle size is extremely small, and consequently the total particle surface area is comparatively large. Given the tendency for soil particles to retain a surface layer of water, it can be seen that the smaller the particle size, the greater is the potential for water retention. Furthermore, each clay particle can take up water internally, unlike particles formed by physical erosion. This capacity is accompanied by a tendency to flocculate, or cohere, into larger units.

Mixed with other soil material, clay has the effect of binding or clogging the assorted particles into granules, the size of which tends to increase with the proportion of clay. Each of these granules is capable of retaining water and dissolved minerals essential for plant growth, and it is largely the clay fraction which distinguishes a true soil from a heap of inert mineral fragments.

Organic content The other main component of soil is organic matter. On the surface of undisturbed soil this is present as recognisable plant and animal remains, but under normal circumstances these are subject to continual attack by decomposing agents–soil bacteria, fungi and invertebrates. One consequence of this is oxidisation, caused by certain types of bacteria which favour light, well-ventilated conditions.

Where the soil is sufficiently moist or compact to impede oxidisation, the organic

remains may be converted into humus, a dark spongy material generally found in the upper layers of soil. Humus shares with clay the properties of water retention and flocculation, and is therefore important in soil formation. Furthermore, containing as it does the nutrients (such as potassium, phosphorus and calcium) taken up by the plants, it is a rich source of plant food.

Soil types–the rendzina The chemical nature of the soil is subject to modification by the climate. Rain is weakly acidic and dissolves alkaline material. As it filters down through the soil it carries the alkaline elements with it–for example potassium, phosphorus and calcium. Acid material such as silica is unaffected, but is of no nutritional value. Consequently acidity, or the absence of alkaline material, may be equated with nutrient deficiency.

This does not mean that alkalinity implies richness. A high concentration of calcium, for example, is not necessarily matched by equal amounts of the other nutrients, and shallow chalk soils are often significantly poor in major plant foods. Such soils are characterised by an absence of clay and silica, for chalk, being almost pure calcium carbonate, is completely dissolved by chemical erosion. There is consequently no mineral subsoil, and the topsoil is composed of organic material mixed with eroding chalk fragments. This type of soil is called a rendzina.

Well-balanced brown earth The dissolution of nutrients by rainwater does not render them

Above: Chalk downland soil is thin and stony–crops struggle to find sufficient nutrients.

Left: The principal plants to colonize acid podzolised heath or moorland are pine, birch, heather and such species as bilberry (shown here)–they grow in association with saprophytic fungi which enmesh their roots in mycorrhizae and supply them with nutrients extracted from the peat.

Below: The pasque flower grows on lime-rich chalk.

Left: A profusion of gorse and heather – there is evidence to suggest that many of Britain's lowland heaths developed in the wake of clearance for agriculture during the Bronze Age, when beneficial deciduous tree cover was removed, thus exposing the brown earth forest soils to the leaching effects of rainfall. In contrast, poor soils have had their character altered in recent years by reclamation techniques.

inaccessible to plants. Acidic conditions only develop if the alkaline solution drains away. In our temperate lowlands rainfall is balanced by evaporation: if the soil is sufficiently full-bodied to prevent rapid drainage, the nutrients tend to crystallise out of the solution as fast as they are dissolved, and the status quo is maintained. Nevertheless, there is normally some downward flow of alkaline material; it is replaced from the humus in the topsoil. This type of soil is known, appropriately, as a brown earth, for the even distribution of alkaline nutrients is indicated by the brown tint given by dissolved iron oxides, extending well down into the subsoil.

'Ash-soil' Where, for some reason, the alkaline solutions drain away too fast for the evaporation process to salvage the nutrients, the upper layers of soil become completely denuded and acid, assuming a bleached, ash-like appearance. The alkaline material collects below this region, in a layer stained dark red-brown by the iron compounds. These may form a hard 'pan' which arrests further drainage. This type of soil is called a podzol, a Russian word meaning 'ash-soil'. It is common on free-draining gravels and sands, and in areas where a cool, wet upland climate in which rainfall exceeds evaporation by a wide margin, acts upon soils derived from acid silicious rock.

The gleys The opposite effect – of drainage impeded to the point of stagnation – occurs in very heavy soils eroded out of an impermeable substrate of sedimentary clay. Such soils remain waterlogged in patches for much of the year, and exhibit a characteristic colour mottling of brown and blue-grey. This effect, known as gleying, is caused by the action, respectively, of aerobic and anaerobic micro-organisms on the iron compounds. The proportion of blue-grey material indicates the degree of saturation with stagnant water; this soil is called a stagnogley.

A similar pattern, an alluvial gley, may be induced by the welling up of ground water from below, as occurs in low-lying areas influenced by seasonal flooding. Below the permanent water table the soil is uniformly waterlogged and anaerobic. In the fluctuation zone it is mottled with grey anaerobic patches. Above this the soil is unaffected, and may resemble that of a brown earth. Because the nutrients are not leached out by drainage, gley soils are potentially very fertile, but their agricultural value is limited by the standing water and by their tendency to become compacted and unworkable under the weight of farm machinery.

Coping with nutrient deficiency The ecological implications of nutrient leaching and anaerobism are profound. In a brown earth

Right: The even distribution of nutrients in a brown earth is partly the result of a healthy soil fauna, in particular the activities of earthworms which, by processing material from lower levels and voiding it at or near the surface, help to counteract the downward flow of nutrients. They also aerate and enrich the soil by dragging plant debris into their tunnels. Earthworms are scarce in heathland soils because the heather and conifer remains are acid and unpalatable.

Soil structures

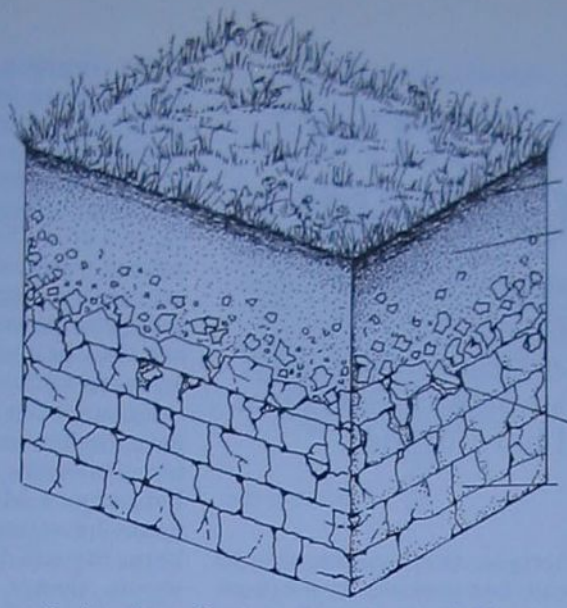
Fundamentally soil is composed of broken down eroded bedrock, clay, humus enriched topsoil and organic debris (right).

Brown earth soil profile (far right) This soil usually has a loamy texture and is very fertile. The even spread of alkaline nutrients is shown by the brown tint (dissolved iron oxides) that extends well down into the subsoil. The horizon between topsoil and subsoil is indefinite.

Rendzina soil profile (left and far right) Shallow chalk soils are recognisable by their lack of clay and silica. Since chalk is almost pure calcium carbonate, it is completely dissolved by chemical erosion. There is therefore no mineral subsoil at all, and the topsoil is made up of organic material mixed with eroding chalk or limestone fragments. Chalk soils are often significantly poor in major plant foods—alkalinity does not necessarily imply richness.

Podzol soil profile (left and far right) Humus, iron and nutrients drain through the sandy soil and collect in a hard iron 'pan' which arrests further drainage. This type of soil is common on free-draining gravels and sands and in areas where a cool, wet upland climate, in which rainfall far exceeds evaporation, acts upon soils derived from acid, silicious rock. Below the iron pan the soil is much healthier than the leached sandy soil above.

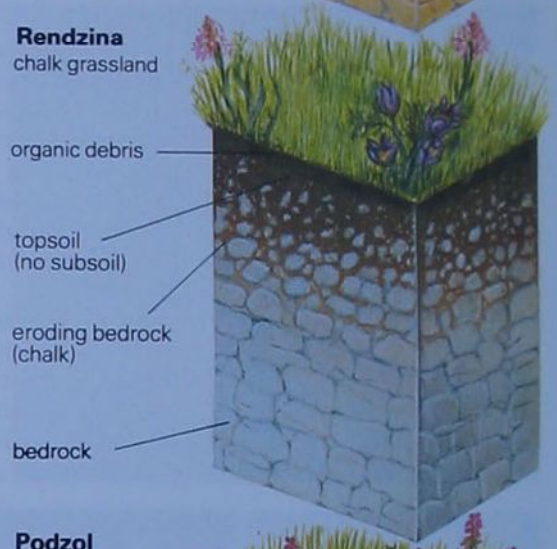
Gley soils In a stagnogley (right) drainage of water is impeded to the point of stagnation by an impermeable substrate of heavy clay. Such soils, waterlogged for much of the year, exhibit a characteristic colour mottling (left) of brown and blue-grey; this is caused by the action of aerobic and anaerobic micro-organisms on the iron compounds. A similar pattern, an alluvial gley (far right), may be induced by the welling up of ground water from below.

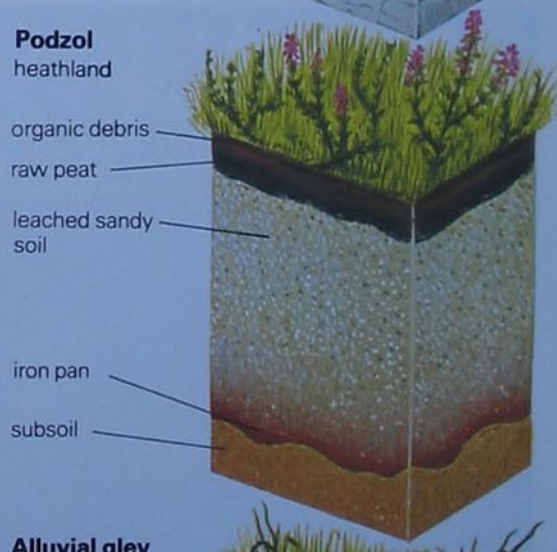


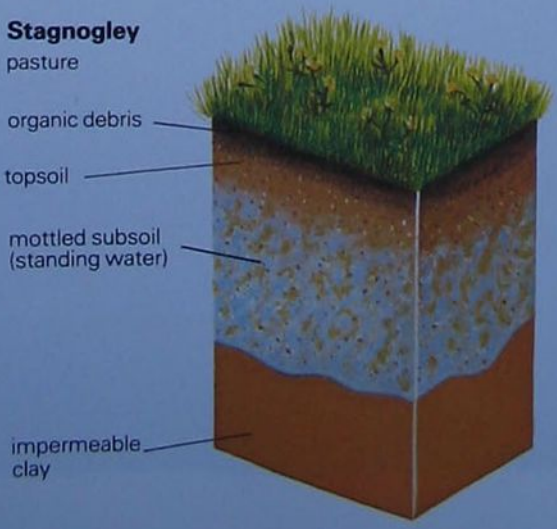
soil the plant foods are made available by micro-organisms which break down organic material into humus and convert the nutrients into a form readily absorbed by plant roots. The majority of these micro-organisms are unable to function under acid or anaerobic conditions; consequently podzols, and soils that are permanently waterlogged, develop a substantial surface layer of unmodified plant remains—or peat. Raw peat is of little value to plants; if they are to survive they require either a new source of nourishment or a way of extracting it from peat.

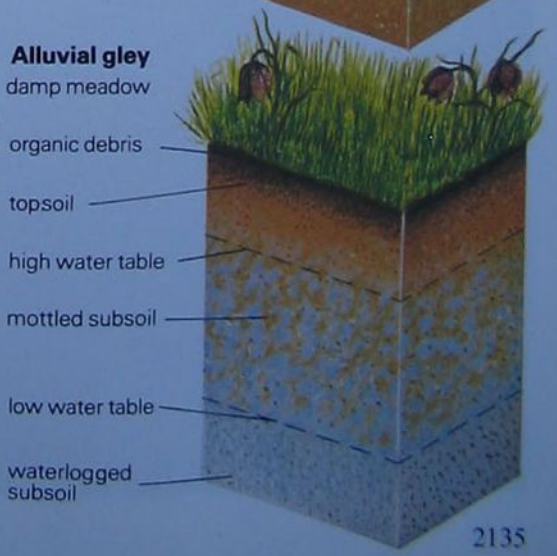
In alkaline but waterlogged conditions water-tolerant plants can extract the nutrients dissolved in the water and a flourishing wetland ecosystem, or fen, develops. In acid conditions, however, free nutrients are in short supply. Sphagnum moss, characteristic of wet acid areas, acquires them by absorbing vast quantities of water and replacing the nutrient atoms with hydrogen. This acidifies the water; consequently, if sphagnum mosses become established in fenland, it is converted into an acid-rich habitat.

Other solutions to the problem of overcoming nutrient deficiency are shown by the carnivorous plants that trap and digest insects, and by the saprophytic fungi that derive nourishment directly from dead organic materials.









EARLY-FLOWERING CORNELIAN CHERRY

Not all plants called cherries are true cherries. A case in point is the cornelian cherry, a shrub grown mainly for its show of flowers in late winter, although this versatile species also provides a source of tasty fruits and a useful hard timber.

Below: A cornelian cherry bedecked with blossom. This species is one of the earliest shrubs to come into flower—usually in February or March—and has been planted in the British Isles for this purpose for at least 400 years. Yet it has never managed to become naturalised here, as it has in most other parts of Europe.
In the wild, the cornelian cherry occurs as a constituent of mature woodland and is also common in thickets and scrub.

The cornelian cherry is a common tree around the Mediterranean, being native to southern and central Europe and western Asia. In those parts of Europe where it is not native, the cornelian cherry has become widely naturalised, mainly as a result of having been cultivated as an ornamental for so long. It has been grown in Britain since at least the 16th century, but it has never succeeded in escaping to the wild here.

False cherries The cornelian cherry or, to give it its scientific name, *Cornus mas*, is not related to the true cherries, which belong to quite a different genus, *Prunus*. It is closely related to the dogwood (*Cornus sanguineum*), a native shrub common on chalky scrubland.

The cornelian cherry can grow to become a small tree up to 8m (25ft) tall, though it is more often seen as a shrub. It has greyish branches, with yellowish-green younger twigs, covered with fine grey hairs. The leaves are borne in opposite pairs and are oval, narrowing to a point. Each leaf has three to five well-defined pairs of veins. That the leaves are arranged in opposite pairs on the cornelian cherry is one important difference between it and the true cherries, whose leaves are always arranged alternately along the twigs.

Except when it is in flower or bearing fruit, the cornelian cherry is a fairly undistinguished tree. It flowers early in the year, normally in February or March before the new season's leaves have begun to grow. The flowers are borne in small dense heads, with the flowering shoots always appearing on the previous year's wood. Each flower head contains between ten and thirteen bright yellow, four-petalled flowers. Here is another difference between the cornelian cherry and true cherries: the latter have larger, five-petalled flowers, which are arranged in looser heads.

The fruit of a cornelian cherry is an elongated berry containing a single stone. It starts off green and matures through white to ripen gradually into the bright red berries that gave the plant its misleading common name.

Tough timber The timber of the cornelian cherry has long been used for a variety of purposes because it is extremely tough. In-

deed, the Latin name *Cornus* means 'horn' and was given to the plant because its wood was said to have the toughness of a horn. Its hardness was known to the ancient civilisations of Greece, Rome and Persia, which all used it as a shaft-wood for spears, javelins and arrows.

On a less war-like note, the wood has also been used to make forks, ladders, spokes and other parts of wheels, pins and wedges. Young branches were used as butchers' skewers.

Versatile fruits The fruit of a cornelian cherry is tart, but pleasantly so, and can be eaten by itself. It was once very popular in Britain made into a syrup called 'Rob de Cornis'. The fruit can be made into a preserve and also used for jam, although it is best mixed with another fruit such as apple because it does not, by itself, possess enough pectin to make the jam set. The fruits can also be used to make wine.

The fruits have had various medicinal properties attached to them. They were reputed to be useful in the treatment of dysentery (as were many other fruits) and the Turks used them as a remedy for cholera.

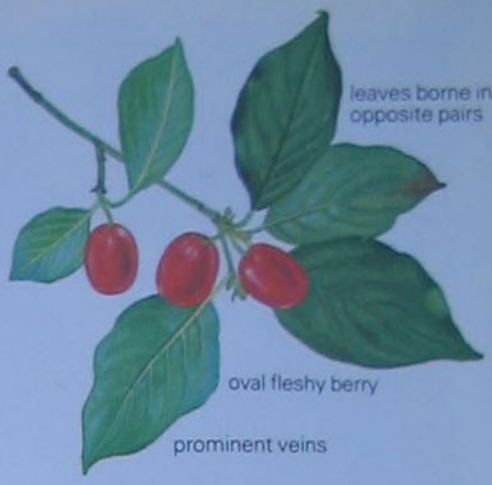
There is ample evidence, from such sources as old writings, that the cornelian cherry fruited much more liberally in this country during earlier times. This is almost certainly a climatic effect, suggesting that the summers of long ago really were as long and hot as nostalgia brings to mind.

Garden favourite The cornelian cherry was introduced to Britain by gardeners, not for its abundant and versatile fruits or for its timber, but because it filled an important gap in the gardener's calendar. Any garden–large or small–looks bare in the depressing days of February and the bright yellow flowers of the cornelian cherry were a welcome sight. Until wych hazels were imported from Japan towards the end of the last century, the cornelian cherry was the most effective of all the early-flowering yellow shrubs.

Today, it is not as commonly planted as it once was, yet the cornelian cherry is still an attractive addition to any garden. It is hardy in most parts of the British Isles and thrives best on chalky soils, perhaps because they are usually a little warmer–like many shrubs from southern Europe it does not relish prolonged cold weather.

Food for mythical swine Being a Mediterranean plant it is not surprising that the cornelian cherry was mentioned in a Greek myth. In his wanderings home from Troy, the great warrior Odysseus chanced upon an island inhabited by the sorceress Circe. He sent men to explore, and Circe, with a conspicuous lack of hospitality, turned them into swine. After she had achieved this remarkable feat she was then faced with the task of feeding these ex-sailors. The mixture she chose was a basic feed of acorns, beech mast and cornelian cherries. It is hoped that this mixture provided some recompense for their ill fortune.

Cornelian cherry



Cornelian cherry (*Cornus mas*). Deciduous introduced tree or shrub, native to central and southern Europe and western Asia. Height to 8m (25ft).

Right: The fruits mature to bright red oval berries up to 2cm ($\frac{3}{4}$in) long. Inside each is a single stone.

Below: The flowers appear in late winter before the leaves unfurl. Each cluster consists of 10-13 bright yellow flowers with four greenish bracts at the base.

THE BLACKBIRD: A JAUNTY SONGSTER

The blackbird – one of the most familiar and best loved of our garden birds – is often regarded as uninteresting because of its very familiarity. In fact, because it is so easy to study, more is known of its life-style than of almost any other bird.

Above: A male blackbird with jet black plumage and bright orange bill. This bird is easily recognisable by its jaunty, hopping gait and also by its habit of standing with head cocked to one side, listening for worms underground. The melodious, fluting song of the blackbird – the one heard most often in our dawn choruses – is also easily identifiable. The blackbird has a danger note as well – a harsh, persistent 'pink-pink-pink-pink' call.

The blackbird, a bird familiar to everyone, is a successful and adaptable species whose natural habitats, before man started to make his mark on the British countryside several thousand years ago, were woodland edges and natural clearings. Now it not only frequents gardens in town and countryside but also most of the hedges over the millions of acres of British farmland.

The blackbird's very numbers allow it to be studied in much greater detail than most species; thousands are ringed each year and nest-recorders are able to find and record nests in great quantities.

Male, female and juvenile The adult male is quite literally a 'black bird', with a wholly black plumage relieved only by a bright orange bill and an orange eye-ring. The younger males, hatched the previous summer, retain their old flight feathers and some wing coverts, giving their wings a peculiar 'patchwork' effect where the old brown juvenile feathers contrast with the newer ones grown during the post-juvenile moult in their first autumn. The females are much browner, with a pale throat and speckling on the breast. Juvenile birds of both sexes have rich brown centres to many of their body feathers, but these are retained only for a month or two.

Territorial song and combat The blackbird's year, in Britain, may be said to start in February when the singing males begin to define their territories for the coming breeding season. This is not only accomplished through the exceptionally melodious medium of their song – used by the birds to announce their presence and continuing occupation of their territories – but also by physical displays.

These displays are particularly visible on a lawn, where two males may posture at each other for periods of ten or twenty minutes at a time. Often they never come to within a metre of each other but, just occasionally, physical warfare breaks out. Later in the season, when the adjacent males are both paired, such posturing (and even fights) may have extra protagonists – three or even four territories may meet on a lawn and the females may join in.

A long breeding season It often seems as if the blackbird breeding season extends from early April through to the end of May. This is indeed the time when they are at their most conspicuous, but many pairs already have a nest with eggs in the middle of March (or even earlier), and may continue with breeding attempts right through to July or even early August, provided the weather is suitable. Early broods are often quite successful for the predators, such as cats, jays, magpies and crows, which take such a toll on nests, are not yet active.

During April, when most species have started to nest, the blackbird's success is at its lowest (although clutch size is then at its highest); success is higher in May and June when there is plenty of cover for the birds to nest in.

The clutch of three to five (sometimes six) eggs is laid in a nest which, although it contains a layer of mud, is lined with grasses. The blackbird's eggs are a dull blue-green with reddish-brown speckling.

Incubation, carried out mainly by the female bird, lasts for about a fortnight from the laying of the penultimate egg, and the young are then fed–on worms and other animal food–at increasingly frequent intervals by both parents for two weeks before they fledge. This is their most vulnerable period for they are still unable to fly for up to 36 hours after fledging and are at the mercy of cats or any other predator able to withstand the brave and noisy attentions of the parent birds. The youngsters may be fed by their parents for a further three weeks–first by both and then later only by the male, as the female will already be sitting on her next clutch.

The annual moult At the end of the breeding season–which may be as early as mid-June in a dry year when the blackbirds are unable to find their food easily, or as late as mid-August in a wet summer–the adults undergo a complete moult to replace all their feathers. At the same time the partial moult of the juveniles takes place and, for a few weeks, the blackbirds, although still present, are not at all easy to see.

However, a little later they become much more conspicuous, particularly to anyone with an orchard and windfall apples or with ornamental shrubs bearing a good crop of berries. Although worms are readily taken at all times of the year, most of their food during the autumn and winter is fruit (where bird-table food is not being exploited).

Urban versus country populations Our own breeding blackbirds are mostly fairly sedentary, although ringing has shown some movement, particularly from northern and upland areas in winter. Indeed, it is certain that the majority of blackbirds hatched in Britain move no more than a kilometre or two from their natal territory throughout the whole of their lives. This has enabled detailed research to unravel the different pressures on different

Identifying the blackbird family

Blackbird (*Turdus merula*). Resident in town and country gardens, hedgerows, woodland edges throughout the British Isles. 25cm (10in).

Right: An albino blackbird. This species seems to be prone to albinism, as many records show. The birds may be partially albino, with just a few white feathers here and there, or pure white, as here.

Below: A female blackbird sunbathing, with wings spread wide. Note the speckling on the breast. Blackbirds are one of the most common bird species of British gardens, on a par with the robin and the acrobatic blue tit.

Above: A juvenile blackbird – the body feathers of the young birds often have rich brown centres.

Left: A blackbird's nest (close to the ground) and the eggs. Unlike the nest of the song thrush (a close relative of the blackbird), which is just made of bare mud, this nest is lined with grasses. A clutch of three to five eggs is usual.

Below: A young blackbird in first-year plumage, with brown primary feathers.

populations of blackbirds.

In urban habitats it appears that adult blackbirds survive very well indeed – the food provided for them on bird-tables keeps them fit and healthy through even the coldest weather, and the experience of their first few years of life teaches them, as it does most urban birds, to avoid cats and cars. Their nests and eggs are, however, much more likely to be preyed upon or fail for other reasons and the few young that they raise have a difficult time surviving all the hazards of city life.

In the country, on the other hand, more young are produced by each breeding pair and they are able to survive better – which is just as well, for the overall adult mortality is higher in the country than it is in urban areas. This seems to be due largely to shortages of food during the winter – urban birds, which have access to more food, put on a greater amount of fat in hard weather to keep them going.

Since they are easy to observe, blackbirds are among the best species to keep notes on. For instance, if the birds in your garden are territorial, or possess distinguishing features, it is possible to list the feeding preferences of particular individuals.

Communal roosts During the winter, in particular, blackbirds spend their nights together in communal roosts. These are often at traditional sites and it has been shown that they chose areas which offer them shelter and safety from predators. The shelter enables them to conserve heat most efficiently, and gathering together in one roost may even serve the birds as an information exchange, so that those with sub-standard feeding sites are able to follow out those who know of the best feeding areas.

These roosting birds are not just the home-grown British population, for vast numbers of blackbirds from Germany, Denmark, Norway, Sweden, Poland and Finland come to Britain for the winter and join our own birds. Many British birds stay in their own home territories but, although some remain territorial, many tolerate visits from the foreign migrants. In the spring, when our own birds are just starting to breed and have already acquired their bright orange beaks, many of the migrants still sport their dull brown winter beak colour.

Albino blackbirds One feature of the blackbird species is that it is prone to albinism. There have been many records of pure white male blackbirds which still show the orange (or yellow) beak and eye-ring (and, in the albino, legs). Often the birds just show a few white feathers flecking the plumage, but this is sometimes neatly symmetrical and progressive – becoming more and more apparent year after year. The whiteness does not seem to put the birds at such a disadvantage that they get caught by cats or other predators, however. In some areas the albinism is transmitted genetically within the population, and pockets of partially albino birds persist for several years.

THE BOOMING BITTERN

The vast, flat, waving reedbeds of East Anglia are the home of the bittern – a secretive member of the heron family. Its fortunes in Britain have been mixed – driven to virtual extinction last century, it is now once more a breeding species here.

The bittern is a highly specialised bird, living its entire life in a reedbed sanctuary – feeding, roosting, breeding and wintering in the fastness of the strange, vertical world of swaying reeds.

Changing fortunes In the days before large areas of fenland were drained to form farmland, the bittern was a widespread and common species in lowland Britain. Nowadays, however, with the reduction of its reedbed habitat, the bird maintains a somewhat tenuous place on our list of breeding species.

Indeed, by the last quarter of the 19th century, the bittern had virtually disappeared from Britain, remaining lost to us as a breeding bird for several decades. The drainage of

Previous page: Bittern on its nest among the reeds.

Left: Bittern in flight – note the rounded, owl-like outline, and how it compares with the longer outline of the heron (also shown). In both birds the legs trail in flight.

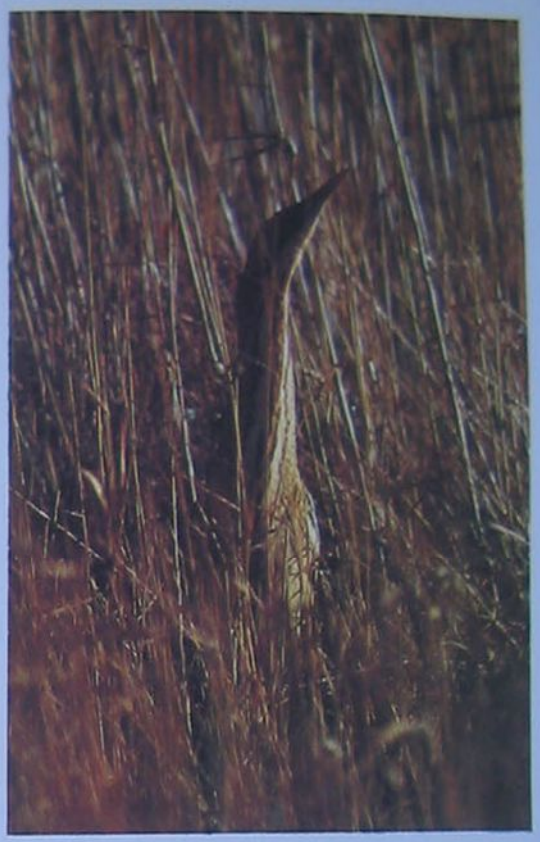
Right: The streaky plumage and neck-stretched posture of the bittern are perfect adaptations for camouflage among old reeds.

Bittern (*Botaurus stellaris*). Resident in reedbeds, chiefly those in E Anglia and Norfolk. 76cm (30in).

Below: An adult male bittern in the typical hunched standing posture of members of the heron family. Note the strong, dagger-like bill and the disproportionately large feet.

the fens, coupled with shooting (for food), egg-stealing and general persecution by man all contributed to the extermination of breeding bitterns in Britain. The last nest was found in Norfolk in 1868.

By 1900, however, bitterns from the Continent started to recolonize the Norfolk reedbeds and, now protected by enlightened landowners, breeding was proved once more by 1911. Slowly pairs spread to such Broadland sites as Hickling, Horsey and Catfield, and by 1930 a small population had appeared in Suffolk. The steady period of build-up and expansion continued and by 1954 nesting was occurring in seven counties, with a total of just over 80 pairs. Leighton Moss, the RSPB



reserve near Morecambe in Lancashire, became a nucleus site in the north-west.

Throughout the past 20 years or so, however, a slow but steady decline has again taken place, the reasons for which are difficult to establish, although water pollution, the effect of hard winters, incidental disturbance through recreational activities and the local effect of reedbed grazing by excessive numbers of introduced coypu probably all played a part. At present the breeding population of bitterns is around 40 pairs, almost all of them on RSPB or other reserves.

Skulker in the reeds The bittern is a somewhat stocky bird, notably thick-necked and with a heavy, powerful bill. It is generally golden-brown in colour, but mottled and barred with black and with a black crown and 'moustache'. The underparts are a paler creamy colour, striped with broken, rufous-brown lines. At any time it is a difficult bird to pick out against the reeds, even when it is in view, but the full effect of the cryptic patterning suddenly becomes apparent when the bird stretches upright, pointing vertically upwards with its bill – the golden-brown markings merging perfectly with the moving background of reeds and the striping on the throat and breast matching perfectly the vertical columns of the reeds.

The bittern has other special adaptations, too. Its feet, on shortish, sturdy green legs, are broad and strong and of disproportionately large size to enable the bird to move with maximum efficiency on the soggy mat of broken and submerged reeds. The yellow eyes have a malevolent and staring quality: they are placed unusually far forward on the

head, close to the base of the bill. This strange adaptation gives the bittern extremely good bi-focal vision for hunting. The bird's amazing cross-eyed appearance can only be fully appreciated if seen from the front.

Booming in the breeding season The bittern is secretive, elusive and a very difficult bird to see, but it does have a uniquely distinctive call which heralds the breeding season. The eerie sound of the bittern's resonant 'booming' is not unduly loud but it has great carrying power and may be heard two miles or more across the marshes on a still day in spring. The booming attracts the females and advertises the occupation of the territory and, in mild years, can be heard as early as mid-February, lasting well into June.

Severe territorial battles can sometimes take place in the breeding season, occasionally leading to the death of one of the combatants. Such extreme hostility is unusual among birds and may be related to the polygamous behaviour of many male bitterns. Bittern aggression is not restricted just to others of its own kind. Much has been written about the mutual antipathy shown between bitterns and marsh harriers; the appearance of an intruding harrier over the bittern's nest site can transform the bittern from a stealthy, secretive bird to a whirling fury, pursuing its adversary with lethal intent.

Mating and nesting As spring develops the bittern pair make short erratic courtship flights over the reedbeds, after which mating normally takes place. The nesting pad is made up of matted reeds and other marsh plants, untidily prepared and soon flattened through use. The four or five eggs are olive in colour, matt in texture and lightly speckled at the large end. The male takes no part in the incubation and in most pairings, particularly polygamous ones, the female is also left with the task of feeding and protecting the young. The fledging period is protracted and it is eight weeks before the young are on the wing.

At the end of the breeding season bittern families break up and the young disperse from their natal areas. Bitterns survive well in places where the water is open throughout the winter, but protracted freezes make feeding impossible; this is when the highest levels of mortality occur among our resident birds, which starve to death.

Feeding habits Within the constraints of the habitat within which it lives, the bittern is a catholic feeder, taking fish, amphibians, reptiles, insects and even small mammals – water voles are certainly vulnerable and often form a substantial part of the bittern's diet. Nestlings of smaller marshland birds also fall victim to the bittern.

Much of the bittern's hunting is carried out on the edge of the reedbed, often – if close to human activity – in the earliest part of the day when there is minimum risk of disturbance from people passing by.

Opposite left: Posturing bittern, seen front-on. Half our breeding population is on RSPB reserves (below).

Below: Bittern chicks on the well-concealed nest. They take 8 weeks to fledge.

CRANE'S-BILLS: WILD GERANIUMS

With their distinctive blue or pink flowers and their curiously long bill-like seed capsules that give them their common name of crane's-bills, wild geraniums are quite different from the garden plants that go under the same name.

Right: One of several introduced crane's-bills, the pencilled crane's-bill (*Geranium versicolor*), a native of southern Europe.

Below: Bloody crane's-bill (*G. sanguineum*) a species of uplands and coastal dunes.

Most people associate the word 'geranium' with the brightly coloured flowers seen in summer gardens and greenhouses. But these are not true geraniums for, although they belong to the geranium family, they do not belong to the genus *Geranium*. They are actually members of the genus *Pelargonium*.

The true geraniums are known commonly as crane's-bills and number some 300 species world wide, of which about 17 are found in Britain. How many of these are native to Britain is not clear, however. Many foreign species have been introduced to this country for growing in gardens and have subsequently escaped to become naturalised here. So it is more likely that only about 12 species of crane's-bill are truly native to Britain.

Group characteristics Crane's-bills may be either annual or perennial. Some perennial species die back completely above ground in the winter, sending up new shoots in the spring. Other perennial crane's-bills retain a small clump of leaves over winter, while a few highly unusual species start into leaf in late summer or autumn, retain their leaves throughout the winter and flower in the spring, dying back by the summer. *Geranium atlanticum*, for instance, follows this cycle, probably because in its native habitat in the Atlas mountains of North Africa drought prevails for much of the summer.

The leaves of all crane's-bills are palmate (ie, shaped like a hand) and grow more or less directly from the base of the plant. The flowers appear on inflorescences, which also grow directly from the base, though some species bear solitary flowers – the bloody crane's-bill, for instance.

The flowers are usually blue or purple, but they may be pink and several species occasionally produce white-flowered forms. Crane's-bill flowers are often large and showy, although on some species they are small and insignificant. Each flower has five sepals and five petals (all separate). The stamens, some of which may lack anthers, number ten and the ovary contains three or five carpels.

The fruit of a crane's-bill is a capsule with a characteristic round base and long bill-like projection that gives the plant its common name. When the capsule opens it splits from the base of the 'bill' into three or five spoon-shaped segments and the single seed inside

each is flung out.

Crane's-bill habitats Crane's-bills are a very successful group of plants, representatives being found in hedgerows and woodland, on roadsides, meadows and wasteland, and in mountainous regions.

In hedgerows one of the commonest species of crane's-bill is herb robert. This is one of the easiest species to identify for it has reddish procumbent stems with small, intricately dissected leaves, which turn a bright red as they die. The flowers are fairly small, about 2cm (1in) across, cup-shaped and pink.

Herb robert is an annual plant; two other annual crane's-bills found in hedgerows and woodland are the round-leaved crane's-bill, with small lobed leaves, and the cut-leaved crane's-bill, with deeply dissected leaves.

Another woodland species, the wood crane's-bill, is a perennial, clump-forming plant. It has large soft leaves with five to seven lobes and can grow to a height of 1m (40in). The colour of its flower varies from a violet-blue (the most common colour) to pink or pinkish-white forms. This species is one of the earliest crane's-bills to flower, its blossoms appearing in May.

Meadow species Grassy places such as meadows and roadsides harbour a large selection of crane's-bills: the dove's-foot crane's-bill, with its purple flowers and small lobed leaves after which it is named; the small-flowered crane's-bill, with its numerous small lilac-coloured flowers; and the long-stalked crane's-bill, which has purplish flowers.

These plants all favour rather dry habitats, where they are sometimes joined by a much larger species, the meadow crane's-bill.

Above: The meadow crane's-bill (*G. pratense*) is found throughout Britain, except for northern Scotland; in Ireland it is rare. This perennial plant has a somewhat localised distribution, but where it is common its bright blue flowers transform a roadside verge in summer.

Right: All crane's-bills have palmate leaves but on none are they so deeply dissected as on the cut-leaved crane's-bill (*G. dissectum*).

Wood crane's-bill (Geranium sylvaticum)
Round-leaved crane's-bill (Geranium rotundifolium)
Mountain crane's-bill (Geranium pyrenaicum)
Dove's-foot crane's-bill (Geranium molle)
Shining crane's-bill (Geranium lucidum)

The mountain crane's-bill has exactly the opposite distribution to the one suggested by its name. This doubtful native of Britain grows in roadsides, hedgerows and waste places in southern England.

Mountain species World wide, many crane's-bills are mountain species but, since Britain is rather lacking in high mountains, we do not have many representatives in this group. However, the bloody crane's-bill is one European mountain species that extends its range to Britain, where it grows among rocks and in grassy areas on chalky soils. This is a perennial, creeping species, as are many mountain plants, but its habit of growth is very variable, and the British plants are much neater and more compact than those on the Continent, which are taller and more straggling.

A rather different upland crane's-bill is the shining crane's-bill, an annual with bright green, shiny leaves, which are often tinged with red, and pink flowers. It grows in the shade of rocky outcrops and hedgerows in limestone mountain areas. It is only locally common in this country but its total range extends across Europe and into Asia as far as the Himalayas.

BLOOD-SUCKING HORSEFLIES

Many people have been attacked or bitten by a horsefly, but few probably realise that only the females indulge in this blood-thirsty practice – an essential part of their egg-laying process. The males subsist on nectar alone.

Horseflies are the largest and most formidable of all blood-sucking flies, some British species reaching 2.5cm (1in) long – a length exceeded by few foreign horseflies. Nearly 30 species occur in Britain, but fortunately most of them are considerably smaller than these giants.

The varying groups of horseflies are known popularly under different names. 'Clegs' refer to the smaller species, while the other small ones with banded wings are called 'thunder-flies' – or 'deer-flies' in America. The term 'horsefly' may be restricted to the larger species, which are also sometimes called 'breeze-flies' or 'stouts'. However, all belong to the family Tabanidae and have similar habits.

Why a blood-meal? The most familiar and unpleasant of these habits is that of biting mammals. The females must have a blood-meal before they can lay their eggs. This they seek with the utmost ferocity and determination in the daytime, generally in hot sunshine although some of the smaller species are also prevalent in close thundery weather. They seldom bite when indoors. Their main source of blood comes from mammals – birds and reptiles are rarely, if ever, attacked.

The males do not take blood, but subsist on nectar, which is also taken by the females, their blood-meal being used only for egg production. Females are the sex most commonly seen (and experienced); males are rarely observed as they fly high, only coming down to take nectar or to drink water.

The bite Despite the horsefly's large size and robust build, the female's biting mouth-parts resemble those of mosquitoes and midges in structure, although they are larger and therefore make a bigger hole in the victim's skin – drops of blood are often seen oozing out. Horseflies take their meals partly by sucking and partly by mopping up with the sponge-like lobes on the lower lip. The females often become gorged after feeding for a few minutes, but equally they may continue drawing blood for as much as half an hour, sometimes moving from host to host, especially if they are disturbed.

They are essentially pests of hoofed animals

Above: The head of the common cleg, showing its brightly coloured compound eyes made up of thousands of minute facets. Its mouth-parts – also seen clearly in the picture – are larger than those of most insects and therefore leave a big hole in the victim's skin.

Right: *Chrysops relictus* mating. Prior to this the males form mating swarms – a necessary action to give them the stimulus essential for successful reproduction.

– horses, cattle and deer – but they may attack other large mammals, such as pigs, dogs and, of course, human beings. The effect of the bite varies from individual to individual, sometimes causing little or no inconvenience, but at other times becoming septic.

When horseflies are abundant, farm livestock can suffer severely and the milk yield of cows may be substantially reduced. There are records of as many as 30 to 40 clegs settling on a man's back and of 200 being killed on four working horses in a few minutes. Although numbers like this can be experienced abroad, they are unusual in Britain since horseflies are rarely as common as this.

Lengthy life-cycle Recent studies of the common cleg have provided us with an insight into the horsefly's life-cycle. The adult female lives for only three or four weeks and in this short period she must mate and lay her eggs. The first task is to find a suitable male – in a mating swarm – since she cannot take a blood-meal until she is fertilized.

Having mated and fed on the blood of a mammal, the female waits a week or more for her eggs to mature, feeding in this period on nectar, but taking no more blood. After one or two weeks she lays between 100 and 150 eggs in a large batch placed in two tiers on a leaf or stem in moist conditions. When a female has laid one batch of eggs, she searches for another blood-meal and then waits for a second, but smaller, egg batch to mature. Altogether a female cleg may lay over 200 eggs in her life and take two or three blood-meals.

The larvae hatch after about a week and drop down to the soil. Here they burrow down and feed as fierce carnivores on small creatures, including other horsefly larvae, although earthworms are thought to be their staple diet. As with all Diptera, they are legless, but have circlets of swellings on each abdominal segment to help them crawl through the soil.

Above: *Chrysops caecutiens*, the commonest of our four species of deer-fly, is a more colourful insect than the cleg. *Chrysops*, meaning 'beautiful eyes', refers to its striking eye coloration (golden or reddish-green and marked with purple lines and spots), while *caecutiens* means 'blinding' – this species prefers to attack at head level, giving severe bites to the victim's forehead, just above the eyes, which can temporarily interfere with sight.

After seven or eight moults the larvae pupate in the soil, generally in late spring. Two to four weeks later the pupae wriggle to the surface, using rings of spines on the abdomen, and the adult flies emerge by splitting their pupal skin.

Dull grey cleg The cleg (*Haematopota pluvialis*) is by far the commonest species of horsefly. At 8-11mm ($\frac{1}{3}$-$\frac{1}{2}$in) long, it is a most aggressive species and is found throughout Britain and Ireland. Its body is longer and narrower than that of most horseflies, dusky in colour and with greyish markings. The wings, held in a roof-like position when at rest, are suffused with grey, relieved by rosettes of paler markings. The eyes – the most spectacular feature – are shiny coppery-green or bluish-green, with dark brown edges and zig-zag horizontal lines.

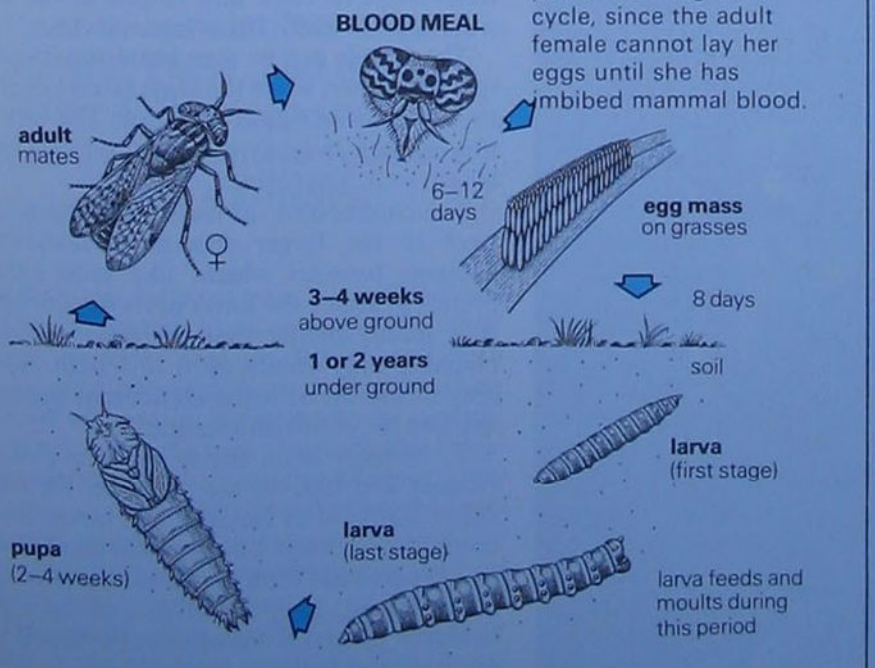
The cleg has been called 'the most obnoxious of flies' and it is not difficult to understand the reason. The female alights extremely quietly when seeking a blood-meal, so that the first warning you have of its presence is a slight prick – usually on the wrist. It is sluggish when feeding and so can easily be picked off or killed, although it is usually too late to prevent the damage.

Deer-flies The commonest of our four species of deer-fly, *Chrysops caecutiens*, is 8-11mm ($\frac{1}{3}$-$\frac{1}{2}$in) long. It is a colourful insect with an abdomen that is yellow at the base and marked with a heavy black X. The wings have a broad dark transverse band so there should be no difficulty in recognising it.

Following a blood-meal – it usually attacks at head level – the female lays her eggs on leaves and twigs near the edges of ponds and

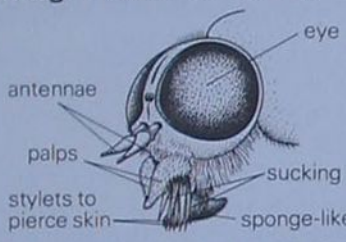
Life-cycle of the female cleg

The blood meal is a vital part of the cleg's life-cycle, since the adult female cannot lay her eggs until she has imbibed mammal blood.



Left: By far the largest and bulkiest of our horseflies is *Tabanus sudeticus* which, with a wingspan of almost 5cm (2in) and a length of 2.5cm (1in), is guaranteed to strike fear into the stoutest of hearts as it zooms around its prey in a threatening manner. As a result of its size it is particularly troublesome to farm animals – especially cows and horses. It attacks the unfortunate victims with a loud humming noise and is irritatingly persistent. You are most likely to come across one in an ancient woodland such as the New Forest in summer.

Taking a meal of blood



The blood-sucking female horsefly has mandibles (jaws) and maxillae (accessory mandibles) in the form of slender, sharp, dagger-like stylets, which are the main piercing organs. A sucking tube is formed by the horsefly's upper lip and the floor of the mouth held together. The stylets and tube are held in the grooved lower lip which, in addition, has two sponge-like lobes to mop up the blood. This lower lip is held out of the way while the stylets pierce the victim. Horseflies take their meal partly by sucking and partly by this mopping-up action.

Below: *Tabanus bromius*, in common with most other horseflies, prefers to attack the lower parts of the body. Its eyes are enormous and, in the case of the male (below), are specially geared towards finding a mate. The upper area of the compound eye is composed of enlarged facets which enhance the male's ability to pick up the movement of potential mates at a distance, while the improved close-up vision of the lower facets helps him identify the female when she is closer. *Tabanus bromius* is usually seen flying from June to August.

streams, usually placing them in batches with only one layer. When they hatch the larvae live for a year in the mud at the sides of ponds and streams or in heaps of rotting aquatic vegetation. Adult deer-flies are on the wing from the end of May until the middle of September. They are found all over Britain but not in Ireland.

Another species, *Chrysops viduatus*, has a single dark spot in the yellow at the base of the abdomen, and a similar distribution to *C. caecutiens*, while a third species, *Chrysops relictus*, has a pair of diverging black marks at the base of the abdomen and is found in Ireland as well as Britain.

Humming giant By far the largest of our horseflies is *Tabanus sudeticus* which, at 2.5cm (1in) long, is a formidable sight as it hums around its prey. It is fairly frequent in the New Forest and in other areas of ancient woodland in Britain and Ireland. The abdomen is dark with pale median triangles from front to back and tinged at the sides with reddish-buff. The wings are clear.

The female can be seen pestering livestock in the summer, while the male hovers over the tops of trees in bright sunshine. The larva of this species lives in the soil and reaches a length of 3.7cm ($1\frac{1}{2}$in).

The commonest – at least in southern England – of the larger species of horsefly is *Tabanus bromius* which, like most others, prefers to attack the lower parts of your body. It is much smaller than *Tabanus sudeticus*, reaching only 16mm ($\frac{3}{4}$in) in length, and is greyish brown with the abdominal segments marked by yellowish triangles.

T. bromius is on the wing from June to August and has, so far, not been found in either Scotland or Ireland. The larvae live in damp turf or moss but can exist in relatively dry conditions, feeding on earthworms and insect larvae. They are large and have particularly powerful mouth-hooks which can prick your skin if you handle them.

FROND-LIKE FEATHER STARS

Two species of feather star occur in our shallow coastal waters. These, and the sea lilies of the deep sea, are the most primitive relatives of the starfishes.

Dwelling for the most part beneath the low tide mark, feather stars occasionally occur in the intertidal area on British and Irish coasts, thus providing a chance to see these animals without diving beneath the surface. Seen exposed on the rock, they look like somewhat formless pinkish tangles of fibres a few inches long. But under water they are delicate-looking creatures, with numerous frond-like arms that bear some resemblance to feathers – hence their common name.

The crinoid group Feather stars and their relatives the sea lilies together make up the crinoids, one of the five living groups of echinoderms. The other echinoderms are the starfishes, sea urchins, brittle stars and sea cucumbers. The crinoids are the most ancient group of echinoderms, having been abundant in the seas of the Palaeozoic era 300 million years ago.

The sea lilies are the most primitive of all echinoderms, and were the forerunners of the feather stars. Today 80 species of sea lilies survive around the world. Their habitat is the sea-bed, below a depth of 100m (300ft) and so they are not commonly known. They look like flowers, for they consist of a crown attached to the sea bottom by means of a stalk up to 1m (3ft) long. Feather stars, too, have a crown, but they have evolved the ability to move around – they have lost the stalk and either swim or crawl. They attach themselves temporarily to the substrate by means of small flexible appendages called cirri, located in a circular arrangement on the underside of the crown. There are some 550 species of feather stars worldwide, and their

Above: The most commonly seen feather star in our waters is *Antedon bifida*; it is also called the rosy feather star. Behind it lies an orange sponge. You can see the ten arms, each of which branches out into pinnules all along its length. The feather star can move its arms into a chosen position, and it can vary the angle at which the pinnules lie in the water. In addition, the pinnules can twist so as to hold their podia (too small to be seen here) in the best position to catch food. The mouth is on the upper side of the crown, surrounded by the bases of the arms.

range extends into shallow waters, right up to the bottom of the shore.

Two British species Only two species of feather star are known to occur in the shallow waters around Britain and Ireland. The most widely known is the red-brown *Antedon bifida*, which may be found from the bottom of the shore at low tide down to a depth of 460m (1500ft). It is most abundant, however, in shallow waters between 15 and 40m (50-130ft), and may reach densities of 1500 per square metre. It grasps on to stones and boulders with between 17 and 40 flexible cirri.

The other British species is *Leptometra celtica*, which has a range of colours including green, brown and a rich red. It is not common in shallow water, but in 1982 it was discovered at a depth of a few metres in the Firth of Lorn on the west Scottish coast, and there have been records of the animal occurring in deeper water in the Minch and in the Shetland area.

Five-fold structure In most echinoderms–starfishes for example–the mouth is situated on the under-surface, but in feather stars the mouth faces upwards. Like all other echinoderms, the feather star has a five-fold structure: five arms branch out from the base of the crown. In *Antedon* and *Leptometra* these basic arms are each subdivided into two, resulting in a total of ten separate arms. The arms are flexible, for they are made up of a row of little bone-like structures (ossicles) with muscle and ligament attachments to allow bending.

It is the deep-water feather stars that usually have ten arms, so *Antedon* is one of a minority among shallow-water species in having ten arms. Some shallow water species produce as many as 40 and a few even have 200. The number of arms may be related to the richness of the food supply.

Each arm branches further, the smaller side branches being pinnules, as in the feather of a bird. The pinnules, however, never lie completely in one plane as in a feather, but are arranged in three planes at angles along the arm, every third pinnule along each side being in phase. The angles between the three planes of pinnules vary with the speed and direction of the prevailing current, for the animal uses its pinnules to catch food–filtering food particles suspended in the passing seawater. Food items include particles of detritus, phytoplankton such as diatoms, and members of the zooplankton such as small crustaceans, protozoans and invertebrate larvae.

Catching food The feather star is able to hold out its arms and pinnules in various positions and orientations when feeding, according to the strength and direction of the current, so maximising the efficiency of the process. In slack water the arms are held in the shape of a cone, a shape modified as current speed increases. The pinnules are able to twist, so holding the longest of the podia (tiny sticky extensions) across the current in such a position as to catch the most food.

Podia arise from the pinnules in tufts of three, and their functions also include gas exchange–taking up oxygen from the sea-

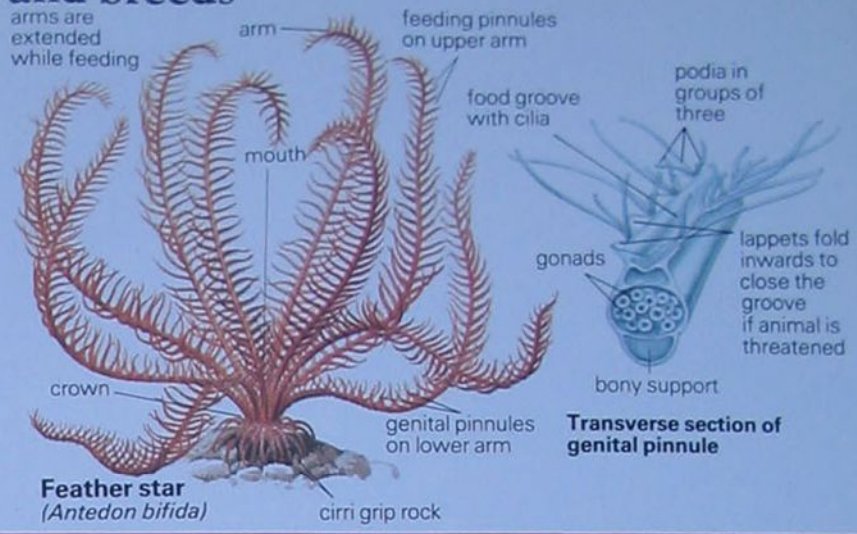
Above: Two rosy feather stars share a favourable spot with numerous sponges. The rosy feather star below is exposed at low water.

How a feather star feeds and breeds

Structure Branching off the main arms are the many pinnules. The ones on the outer half of the arm's length are for collecting food (feeding pinnules), while those on the inner half are both for feeding and for reproduction (genital pinnules).

Trapping food Branching off the pinnules are small sticky extensions (podia). These catch food items and pass them down into a groove. The food is then carried by the movement of tiny hairs (cilia) along the groove, which leads down the pinnule, along the arm and into the mouth.

Reproduction In most species the gonads (sperm or eggs) are contained inside the genital pinnules. When fully formed, they are released into the sea. The sperm fertilise the eggs by chance encounters.



water, and releasing carbon dioxide. Together, the podia have a large surface area and they are thin-walled, thus being admirably suitable for use as a respiratory surface.

Free movement Feather stars have two methods of locomotion – they can crawl or swim. In crawling, the body is lifted clear of the bottom and the feather star moves along on the tips of its cirri. The animal swims by moving its arms up and down alternately, each arm moving in phase. Its usual reasons for moving about on the sea-bed are to find a hiding place or to emerge and take up a feeding position.

In the feeding position, it stands exposed to water currents, perched on the rocks and grasping them with its cirri. Many feather stars are nocturnal, hiding by day and feeding by night.

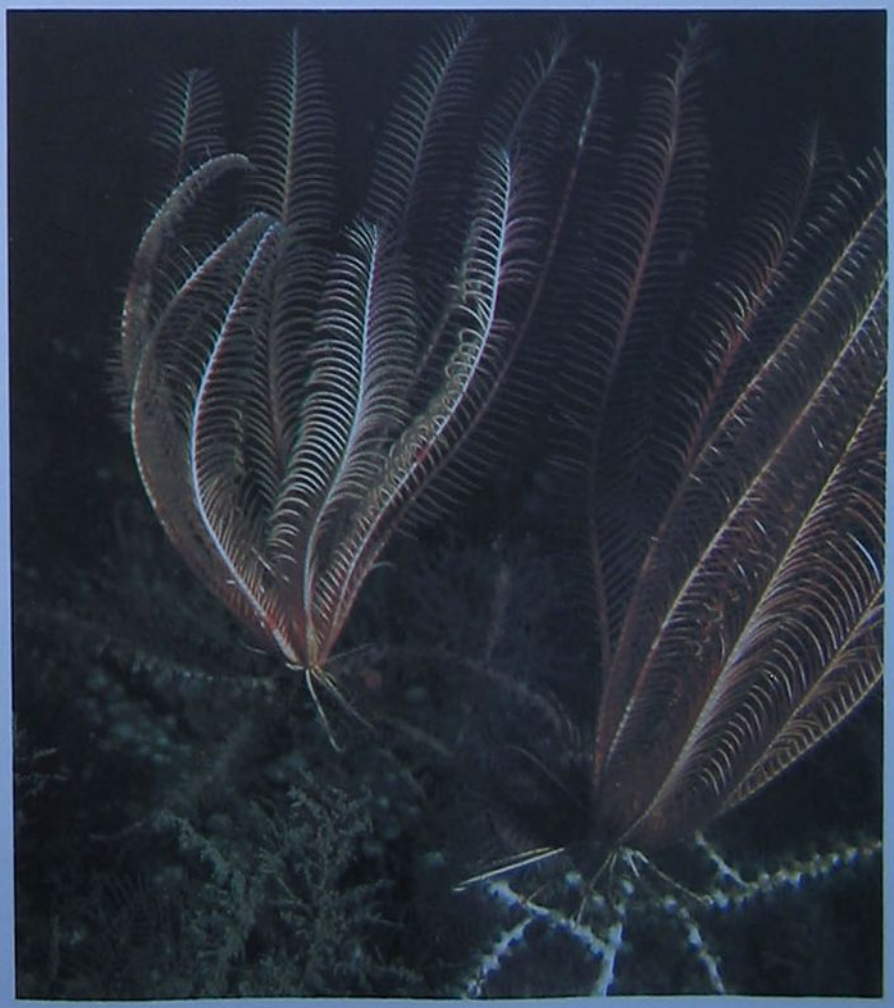
Regenerative powers Feather stars show considerable powers of regeneration: they can replace lost pinnules, cirri and arms by growing new ones. *Antedon* is able to survive the loss of part of the central disc and its associated arm, or even the loss of four pairs of arms, and regenerate the missing portions. Regeneration appears possible as long as the main nerve centre is intact.

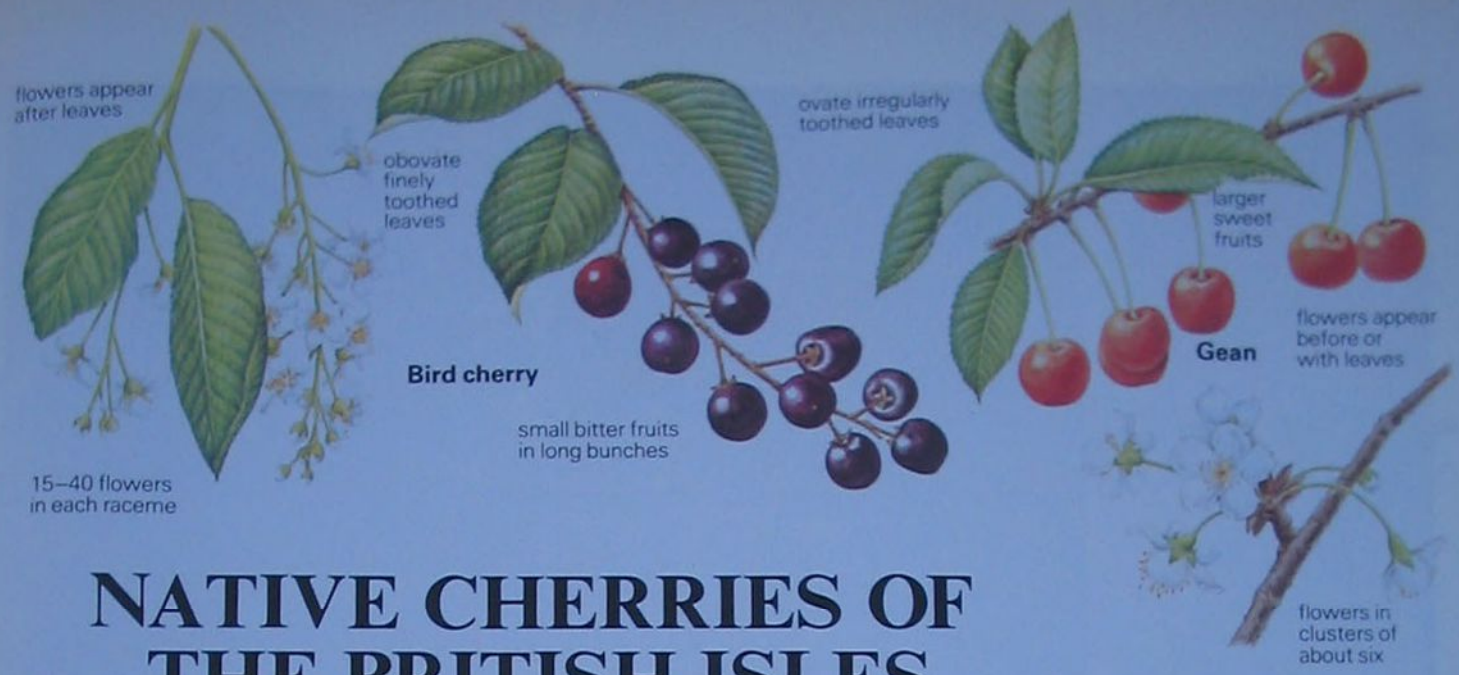
Life-cycle In most species, individual feather stars are either male or female. Some of the pinnules are genital pinnules: these, situated on the inner part of the length of the arm, are used both for feeding and for the creation of the sperm or eggs. When they are fully formed, these burst through the wall of the pinnule and float away in the seawater, fertilising each other if they meet. In most species the fertilised eggs hatch out as free-swimming larvae; these are barrel-shaped and are known as vitellaria larvae.

In temperate regions, *Antedon* breeds in spring and early summer. The vitellaria larva spends only a few days in the plankton until it settles and metamorphoses to form a pentacrinoid larva. This second larval stage is sessile – the larva is attached to the substrate by a short stalk. The pentacrinoid grows to a length of about 3mm before developing arms, approximately six weeks after attachment. After several months the cirri develop and the feather star takes on its mobile adult form.

Antedon is a slightly unusual species in that the fertilised eggs do not float freely but attach themselves to the outside of the pinnules of the parent. They hatch into vitellaria larvae, which live among the plankton until metamorphosis takes place and the larvae develop normally into adults.

Below: Two examples of *Leptometra celtica*, a feather star that is rarely seen in our waters. These were discovered in shallow water in the Firth of Lorn, off the west coast of Scotland, by a scientist taking part in an NCC survey in that area. Previously the species was thought to occur only in water from 70-100m (200-300ft) deep.




flowers appear after leaves
obovate finely toothed leaves
ovate irregularly toothed leaves
larger sweet fruits
flowers appear before or with leaves
Bird cherry
Gean
small bitter fruits in long bunches
15–40 flowers in each raceme
flowers in clusters of about six

NATIVE CHERRIES OF THE BRITISH ISLES

Of all our flowering trees the cherries are among the most popular and the most beautiful. A great many cherry trees in Britain come from the Far East, but there are two native species – the gean and the bird cherry – which, when seen flowering in the wild are every bit as pretty.

Many of the cherry trees we see around us – in gardens, parks and streets – came originally from the Far East. The majority, indeed, were introduced to the West from just one country – Japan, where for hundreds of years gardeners have been breeding cherry trees for their ornamental blossom. Rather less familiar, however, are our own native cherries, the gean (or wild cherry) and the bird cherry.

In the wild, these two species are not usually seen together as they differ slightly in their geographical distributions and soil preferences.

The gean occurs throughout Britain but is commonest in the south and favours deep moist soils. Its preferred habitats are hedgerows and the margins of woodland. The bird cherry, on the other hand, has a distinctly northern distribution in Britain, as it does in Continental Europe and Asia, the gean having a more general distribution in these parts. In Britain, the bird cherry grows on lighter, well-drained soils in limestone regions of the type found in many of the hillier areas of northern England. The natural distributions of the two species have, however, been obscured by the extensive planting of both trees as ornamentals.

Shape and size The gean is usually noticeably taller than the bird cherry. It forms a moderate-sized tree, reaching a height of about 20m (65ft), though occasional specimens may grow to become over 30m (100ft) tall. Its branches spread out widely to form a broad, rounded crown.

The bird cherry, a smaller species, is usually seen as a shrub no more than 10m (33ft) tall, though it too may grow to become a tree up to 17m (55ft) high. The branches of the bird cherry are slender and more upright than those of the gean. In both species the young branches are covered with soft downy hairs, though less so on the gean.

The bark of the gean is a glossy reddish-brown with horizontal bands of light brown lenticels; these are pores in the bark through which air passes into the trunk. On younger branches and the trunks of young trees the bark often peels away horizontally in papery strips, but on older branches and trunks the bark becomes fissured. The bird cherry has a smooth, dark greyish bark which, when crushed, releases a strongly pungent, foetid smell.

Leaf comparison Superficially, the leaves of the gean and bird cherry are similar, except that those of the former are larger – up to 15cm (6in) long, compared with the leaves of a bird cherry, which are no more than 10cm (4in) long. The leaves of both are deciduous, with toothed margins and tapering tips. The upper surfaces are dullish green and smooth; the lower surfaces are paler and often have soft downy hairs along the main veins. Before they fall in the autumn, the leaves turn an attractive red and then yellow, usually changing colour from the margins inwards.

A close inspection, however, does reveal some important differences between the leaves of the two species. The teeth of gean leaves are deep and rather irregular, while the leaves of the bird cherry are more finely

Bird cherry (*Prunus padus*). Native deciduous shrub or tree, more common in northern Britain where it grows in hilly limestone regions. Height to 10m (33ft), exceptionally to 17m (55ft).

Gean or **wild cherry** (*Prunus avium*). Native deciduous tree, more common in southern Britain, especially in woodland margins and hedgerows. Height to 30m (100ft), more usually 20m (65ft).

Opposite page: A gean in spring flower.

Gean
Prunus avium
var *plena*

Bird cherry
Prunus padus
cultivar *'watereri'*

Above: Two garden varieties of our native cherries.

Above right: Gean blossoms just before the leaves show.

Below: The bird cherry flowers a few weeks later.

toothed. The two sets of leaves also have slightly different shapes. The point where gean leaves are at their broadest lies closer to the leaf base than to the tip (a shape called ovate); on the bird cherry the leaves are broadest towards the leaf tip (called obovate). The latter leaves also have rounded heart-shaped bases, and they share the same foetid smell of the bark.

Spring blossom If the leaves of the two species seem similar, the flowers are quite different. The gean flowers from April to May, the flowers opening just before the leaves appear. They are borne on short stalks in small, rather drooping clusters of about six. Each flower has five white petals–deeply notched and about 1.5cm ($\frac{3}{5}$in) long–and numerous stamens.

A gean in flower is a pretty sight but, unfortunately, the spectacle is often short lived: in fine weather the petals may remain on the flowers for little more than a week.

The bird cherry produces much larger clusters of flowers–between 15 and 40 may be present on each elongated raceme, all crowded together on short stalks. The five rounded white petals are smaller than those of a gean (less than 1cm/$\frac{2}{5}$in long) and usually have a minutely toothed margin. The flowers appear in May and are just as short lived as the gean's.

Sweet and sour fruits The two species are equally distinct in their fruits. Gean fruits are almost perfectly spherical, with just a slight depression at the stalk end. By July they have ripened to a glossy red, though a few remain yellow or become black. When ripe they are about 2cm (1in) long and sweet and juicy, sometimes with a very slightly bitter taste. They are avidly eaten by birds and were once harvested from wild trees in Britain to be sold for eating, a practice that continued until the development of modern improved varieties.

The word gean itself (which is pronounced with a hard 'g') is an Anglicised form of the French word 'guigne', meaning sweet cherry. One of the less widely used common names for this species is merry, which also has a French origin, being a corruption of 'merise', a wild cherry. As well as being eaten, gean fruits were also used to flavour brandy, as implied in another of its common names: brandy mazzard.

The fruits of a bird cherry are smaller, only 1cm ($\frac{2}{5}$in) or so across, and like the flowers are borne in large racemes. When ripe they are

shiny, black and spherical, but have a sharp, bitter taste that makes them inedible. Birds, however, seem to enjoy them and devour them eagerly, as the name bird cherry suggests. Other common names for this tree include hagberry, hawkberry and hackberry, all names that emphasize its unpleasant taste.

Timber and rootstock Both the gean and the bird cherry produce an excellent-quality timber, much prized by cabinet makers for its attractive colour and fine grain. However, the wood is available only in small amounts.

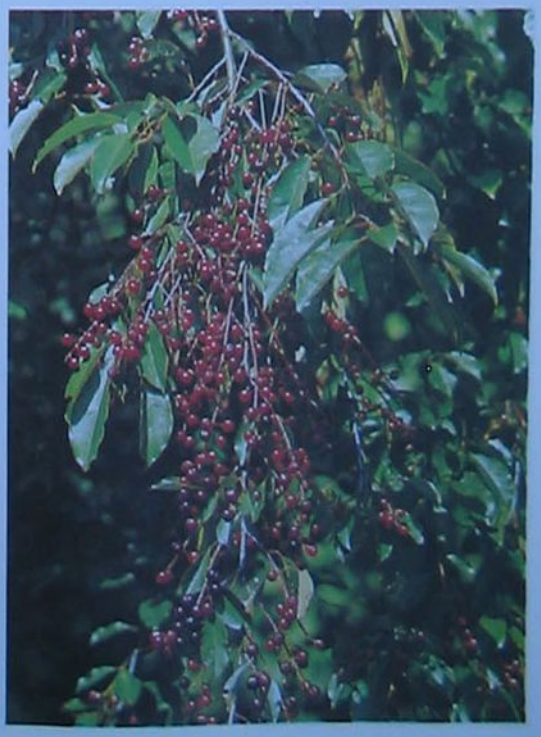
Commercially, a more important use for the gean, though not the bird cherry, is as a rootstock on to which other cherries are grafted. By doing this the grafted cherry benefits from the vigorous and rapid growth of the gean's root system and trunk, while still bearing the desired ornamental flowers or improved varieties of fruit. The use of a gean rootstock is the key to the successful cultivation of many oriental cherries in Britain which, on their own root systems, would grow only very slowly, if at all, in our climate. So if you look at an ornamental cherry, or an orchard cherry, you are likely to see that it has the trunk of a gean but branches that appear quite different, being those of the grafted portion.

Garden and street trees Both the gean and the bird cherry are widely planted in their wild forms, but most specimens of these trees seen in gardens and streets are cultivated varieties, especially selected for their flowers, leaves or habit of growth.

One of the best-known garden varieties of gean is the double-flowered variety *plena* which, in addition to each flower having extra petals, also bears more flowers to a cluster than does the gean. The cultivar '*decumana*' has large leaves, up to 30cm (1ft) long, while '*nana*' is a dwarf cultivar suitable for small gardens, though it is less spectacular in flower than some of the dwarf oriental cherries.

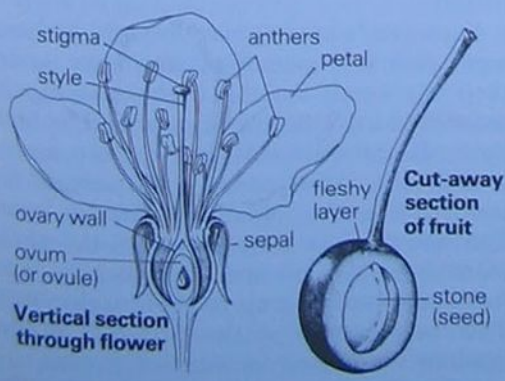
There are just as many cultivated varieties of the bird cherry, though they are perhaps less frequently grown. The most common is '*watereri*', sometimes known as '*grandiflora*' because of its larger, more abundant flowers.

Above: The leaves of both the gean (here) and the bird cherry turn red then yellow in the autumn.



Right: The fruits of a bird cherry hang in unusually long clusters.

Growth of a cherry



At the base of each cherry flower is a receptacle containing within the ovary an ovule. The ovule (the future seed) is fertilised by male cells from the pollen grain that landed on the stigma during pollination. After fertilisation the inner layers of the ovary wall grow to form the stone of the fruit (enclosing the seed) while the outer layers form the flesh.

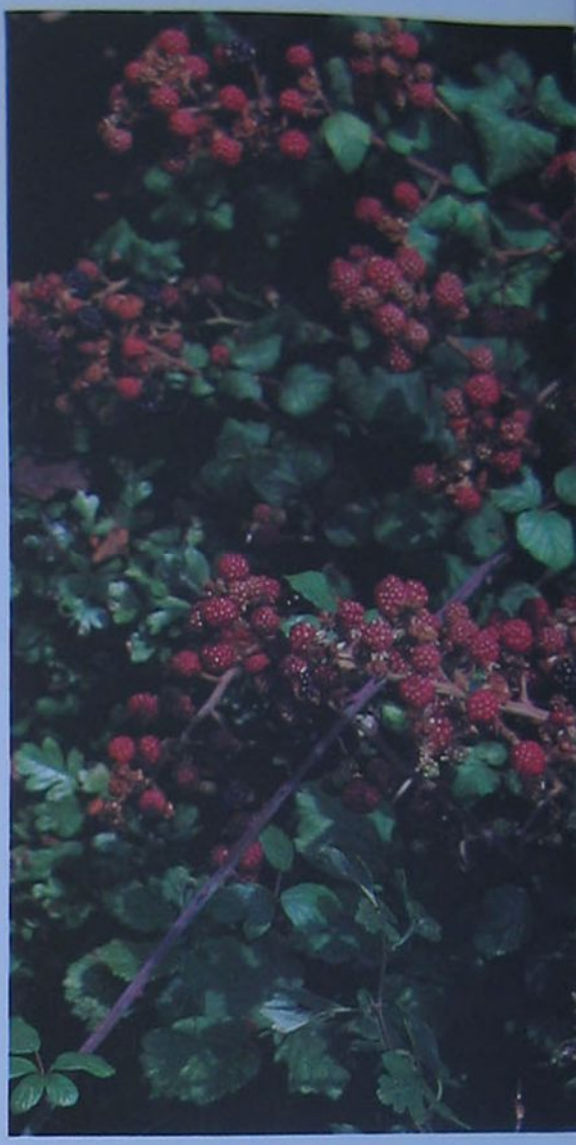
THE WORLD WITHIN A BRAMBLE BUSH

The bramble or wild blackberry is found in scrub, hedgerows and woodland throughout Britain and the thickets it forms are colonized by an enormous range of wild animals who find food, shelter and safety within its thorny, arching branches.

Under the blanket name of 'bramble' lurks confusion almost as tangled as the plant itself. Opinion varies as to whether there is only one bramble, with a multitude of different growth forms, or whether each is truly a distinct type. One authority divides the British brambles into 40 or more species, and over 2000 varieties have been described. But, however many types there are, the bramble or blackberry is immensely successful at colonizing a wide range of soils and habitats throughout the British Isles.

Bramble is, for instance, often the dominant field layer in oak and beech woodland and, though best established in ancient, relict woods, it quickly invades modern plantations and roadsides, its tolerance of shade giving it a major advantage over more sun-loving species. Once bramble has cast its shadow over the woodland floor, few other plants can co-exist with it, except for shade-resistant species such as wood sorrel. Its main associate, however, is bracken, whose fiddleheads can easily snake upwards through the bramble's cat's-cradle of arching shoots.

Right: Brambles can form almost impenetrable thickets, the thorns assisting the branches to clamber over tree branches, shrubs and even fences. Flowers at the tips of stems are the first to set and produce berries. A bramble can bear berries in all stages of ripeness from the hard, pale green ones, through red to the large, luscious shiny black of the ripest fruits. Birds, insects and mammals tend to feed only on the ripe fruits.



Below: This distinctive gall is produced on a bramble stem by the larvae of the gall wasp *Diastrophus rubi*.

Some climbing and trailing plants, notably honeysuckle, also find a solid support in the bramble's trellis-work.

The bramble thicket At first sight a bramble thicket looks as random as an entanglement of barbed wire. But on closer inspection a clear structure reveals itself. A mature thicket has three main layers of 'canes'. On the top there is a thriving leafy zone containing the bulk of the new canopy; these are mostly lateral shoots from the two-year-old canes which, with the remains of the previous year's canopy, form the middle layer. Thirdly there is a leafless bottom layer, containing most of the standing wood and looking grey and lifeless.

Each year's canes grow through the basement layers, eventually falling over under their own weight and that of the canes of subsequent years. Thus the plant scrambles both upwards and outwards over its own ageing understorey. Most canes grow actively for two years before joining the bottom layer. The root stock or root 'crown' of the whole plant is long-lived and continues to send forth new stems for up to about eight years. This new growth is the first line in the bramble's attack on unoccupied ground.

A feast for all Late in the summer, when the

stems arch over to the ground, their tips can send out roots of their own, producing new daughter plants. However, the bramble's introduction to new habitats is mostly accomplished indirectly–by presenting birds and mammals with a bonanza of fruit in the autumn.

The second-year and older canes bear their five-petalled white or pink flowers from May onwards. The flowering season is lengthy and the fruits develop any time from late August to October. The flowers right at the tip of the stem are the first to set and typically produce the plumpest, sweetest fruits. Those further up the stem take perhaps another six weeks to ripen so that, at any one time in late summer, the bramble thicket bears unripe green berries, half-ripe red ones and fully ripe black ones.

The main consumers of bramble berries are –among birds–marsh and willow tits, bullfinches and, to a lesser extent, blackbirds and song thrushes. Among mammals, foxes, badgers and even squirrels and deer are fond of bramble berries. The berries are sought for their energy-rich pulp, while the seeds within pass undigested through the gut and are conveniently deposited in a 'ready-grow' package of manure. This is why brambles can often be found growing in the old latrine pits near badger setts.

Of the animal species listed, only the tits take the trouble to extract and discard the seeds before eating the pulp. The pulp itself is highly digestible, the seeds passing through the gut of a song thrush in no more than about 40 minutes.

Apart from being carried some distance in this time and, with luck, being deposited in a place suitable for germination, there is a further advantage in the bramble-bird association. Bramble seeds sown in the autumn germinate the following spring, provided they experience freezing in winter. However, it has been shown that seeds which have passed through a thrush's gut germinate considerably quicker than ones sown directly from fresh fruit. It appears that in some way, probably by softening the seed coat, the digestive process hastens germination. This presumably gives eaten seeds a clear advantage in spring when countless seedlings are competing to outgrow their rivals in the race for light and space.

Mammal enemies Not all animals, however, are as obliging as the birds. Mice and voles, with their small incisor teeth, are quite able to crunch up bramble seeds–and so may be regarded as enemies. Nevertheless, the prickles are a formidable barrier to many animals. The sharp, recurved thorns tend to prevent small rodents from scaling the stems and such birds as the robin, the thrushes and the long-tailed tit like to build their nests in bramble for this very reason. (However, a weasel has been observed running up the

Left: The wealth of insect life on bramble fruit offers rich pickings for predators such as spiders and insectivorous birds. Garden spiders, like this garden cross spider, ensnare flies and other insects in their elegant orb-webs, while money spiders, such as *Linyphia triangularis,* straddle sheet-like nets across leaves and stems. Eventually, the spiders find themselves, in an oasis of easy prey, slowed down by the chills of advancing autumn, perhaps even intoxicated by the fermenting sap. With the onset of heavy dews and the first frosts, mildew begins to cloud the late berries. In medieval times in England this was a sign that the devil had defiled the crop, and it was therefore deemed unwise to pick blackberries after Michaelmas Day (29 September).

Above and top left: Some of the wildlife found on the topmost layer of the bramble thicket. Red admiral and ringlet butterflies, like the fruit fly, feed on nectar from the flowers and may even sip juices from the over-ripe berries. A snail may be seen crawling up the stem, intent on finding a leaf to feed on. Blotch mines in the leaves are the work of the larvae of such sawflies as *Metallus rubi*. The pupae of such moths as *Epiblema* shelter in silken tents among leaves drawn together for support.

Left: The five-petalled white and pink flowers of the bramble are produced from May onwards through a lengthy flowering season.

Below: Serpentine or tunnel mines produced in bramble leaves by the larvae of the pygmy moth *Nepticula aurella*. The larvae are safely sandwiched between the upper and lower layers of the leaves.

stems of a bramble thicket almost as if the thorns were the rungs of a ladder; in this particular case, the bramble's defences were of no avail to the blackbird's nest sited in the thicket – the weasel plundered it with ruthless efficiency.)

Bramble leaves, especially those on the younger growth not protected by fully developed thorns, suffer considerable damage from browsing animals, notably in spring when the new leaves are soft and highly palatable. But they are probably even more vulnerable in hard winters. Bramble is not deciduous and retains its leaves in winter. These prove remarkably hardy and can withstand prolonged exposure to frost and snow.

Being the only bulk herbage available in winter on the woodland floor, bramble leaves are taken by a wide variety of animals. After the severe winter of 1981–82, for example, the brambles in an Oxfordshire wood showed signs of heavy browse damage, being virtually stripped of leaves. Muntjac deer, and possibly also rabbits and hares, were thought to be responsible. Studies in the south of England have shown that fallow and roe deer eat bramble leaves all year round, but especially in winter and spring. Among domestic animals, goats are extremely fond of bramble, and seem impervious to the prickles as they mow through the densest thickets.

Insect attack Bramble leaves are also attacked directly by less obvious agents such

as rust-fungi–and insects. Each insect group may be identified by the sort of damage it inflicts. Thus leaves that look torn and peppered with holes have been attacked by capsid bugs. The peculiar raised blotches or galleries, looking rather like worm casts, that appear on the undersides of the leaves, are the work of various insect larvae. These larvae, the offspring either of sawflies such as *Metallus rubi*, or small moths, eat their way through the inside of the leaf, sandwiched between its upper and lower layers. Some larvae munch outwards in all directions to form a blister, others along a vein, creating a winding, serpentine corridor or tunnel. The mined areas of the leaf are often white with frass (the waste products of the larvae), while others turn a reddish-purple colour.

None of the leaf-mining insects is well known, and their identification is a tricky process. The pygmy moths (Nepticulidae), for example, contain no fewer than 67 leaf-miners of various British plants, caterpillars of *Nepticula aurella* commonly tunnelling the whitish corridors often seen in bramble leaves.

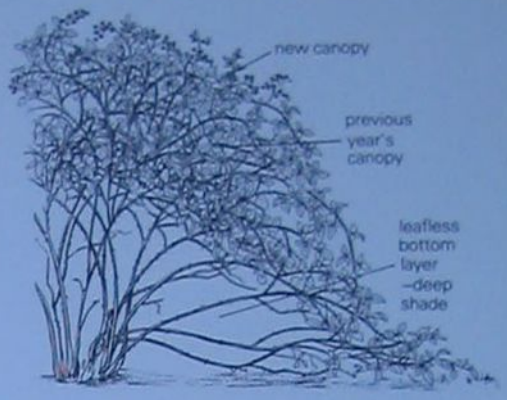
Nepticula larvae spin a saucer-shaped cocoon in which to pupate. These are readily distinguishable from those built by pupal tortricid moths like *Epiblema*, whose caterpillars, emerging from hibernation in spring, move to the tip of a bramble shoot and draw the leaves together as supports for a voluminous silken tent, painstakingly spun as a

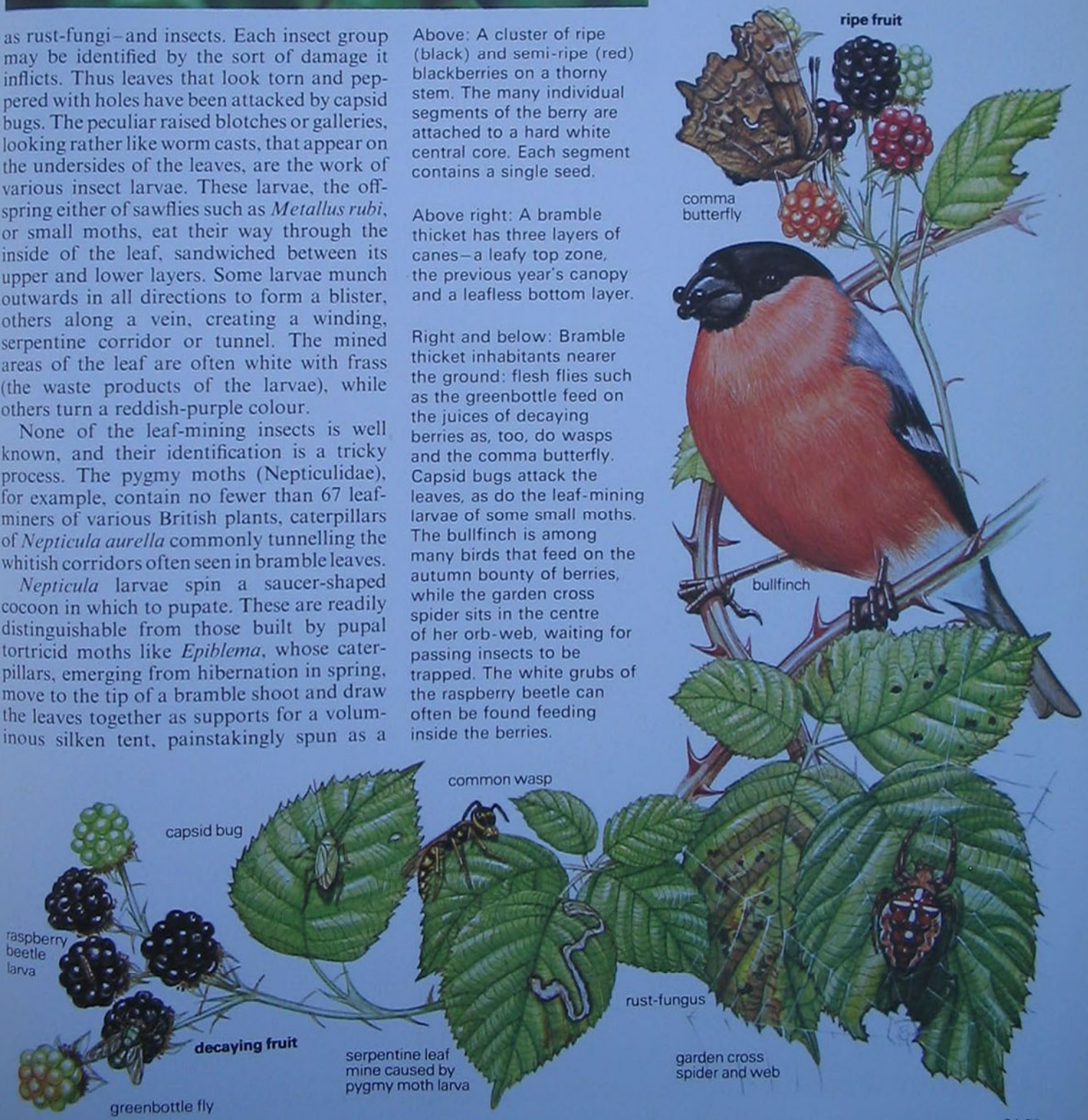
Above: A cluster of ripe (black) and semi-ripe (red) blackberries on a thorny stem. The many individual segments of the berry are attached to a hard white central core. Each segment contains a single seed.

Above right: A bramble thicket has three layers of canes–a leafy top zone, the previous year's canopy and a leafless bottom layer.

Right and below: Bramble thicket inhabitants nearer the ground: flesh flies such as the greenbottle feed on the juices of decaying berries as, too, do wasps and the comma butterfly. Capsid bugs attack the leaves, as do the leaf-mining larvae of some small moths. The bullfinch is among many birds that feed on the autumn bounty of berries, while the garden cross spider sits in the centre of her orb-web, waiting for passing insects to be trapped. The white grubs of the raspberry beetle can often be found feeding inside the berries.

Section through a bramble thicket





pupal chamber.

Even the tough-looking bramble canes are not immune from house-hunting insects. The small gall wasp *Diastrophus rubi* is responsible for the somewhat S-shaped swellings 5-20cm (2-8in) long sometimes found on the stems of bramble. These may be found in any month of the year, varying in colour from green in the early stages, through reddish, to brown at maturity.

The female gall wasp pierces the skin of the stem to lay a batch of 80 eggs or more. When they hatch, the movements of the larvae have an irritant effect on the bramble tissue, which reacts by swelling into a gall. Each larva gouges out a tiny chamber for itself as it eats the gall tissues, so that in vertical section the gall comes to resemble a block of flats. By November, if all goes well, the development of this crowded nursery is complete, and the larvae pupate inside, to emerge as adult wasps in spring.

The larvae within their gall look perfectly secure, but are in fact vulnerable to being parasitised by other species of wasp closely related to themselves. These parasites lay their eggs not in the bramble tissue but in the bodies of the gall wasp larvae, which then become gruesome larders for the parasite species' own offspring.

Above: One of many insect visitors to bramble flowers—a silver-washed fritillary butterfly.

Below: The neat, circular nest of a dormouse, sited safely within the depths of a bramble thicket.

Autumn invaders In September inviting clusters of shiny black berries are hanging from the older shoots. These provide sugary sap for a constant stream of insect traffic. Wasps, their nesting and working duties over for the year, are often the first to pierce the skin of the berries, allowing a host of greenbottles and other flesh flies to glut themselves on the oozing juices. It seems that carrion flies sip blackberry juices as they search for corpses in which to lay their eggs, and it may also help some to build up their energy stores for overwintering.

Much more attractive visitors are the butterflies—notably the comma, speckled wood and ringlet, and the autumn specialist, the red admiral. Few insects, fortunately, live right inside the berries, although the raspberry beetle *Byturus tomentosus* does so, the larvae emerging from eggs laid in the flowers to feast on the developing fruit. Anyone picking and eating blackberries from the hedgerow may well have noticed these larvae—they look like tiny white worms.

An old favourite Despite its prickly thorns, the bramble, a member of the rose family, is as much loved a wild plant as its more decorative relative, the wild rose. Its widespread value to country people as a medicinal herb, a source of refreshing tea and above all as a generous bearer of fruit, dates back to prehistoric times—as testified by blackberry seeds found in the stomach of Neolithic man disinterred from Essex clay. The fruit is a favourite made into jam or jelly, or used in a variety of pies and tarts.

In bygone days, bramble—in common with many other thorny shrubs and trees—was also believed to be an auspicious plant, a powerful talisman against evil forces. The familiarity of bramble to country people, and their healthy regard for it, is celebrated to this day in a host of colourful local names—cock-brumble, brummelty kites and lady garten berries, to name just a few.